THE APPLICATION OF REMOTE SENSING TO RESOURCE MANAGEMENT AND ENVIRONMENTAL QUALITY PROGRAMS IN KANSAS

by

B. G. Barr
Director
Space Technology Center
The University of Kansas

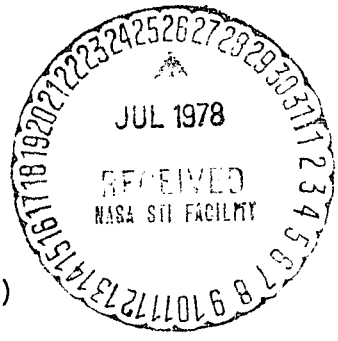
and

E. A. Martinko
Assistant Scientist
Space Technology Center
The University of Kansas

July 1978

An Annual Report of Work
Performed Under NASA Grant
No. NGL 17-004-024

(April 1, 1977 - March 31, 1978)



THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.
2291 Irving Hill Drive—Campus West
Lawrence, Kansas 66045

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J. W. Merchant
J. Poracsky
V. Sehon
R. V. Shaklee
T. L. Talmon
T. H. L. Williams

B. G. Barr, Principal Investigator
Kansas Applied Remote Sensing Program

E. A. Martinko, Co-Investigator
Kansas Applied Remote Sensing Program

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ABSTRACT

Activities of the Kansas Applied Remote Sensing Program (KARS) are designed to establish interactions on cooperative projects with decision makers in Kansas agencies in the development and application of remote sensing procedures. This report describes the activities of the KARS program in pursuit of its objectives during the period April 1, 1977, through March 31, 1978.

Cooperative demonstration projects were undertaken with several different agencies during this period and involved three principal areas of effort: Wildlife Habitat and Environmental Quality; Urban and Regional Planning; Agricultural and Rural Development. These projects were designed to focus remote sensing concepts and methodologies on existing agency problems to ensure the continued relevancy of the program and maximize the possibility for immediate operational use.

Completed projects during the period include (1) the decision to release antelope at selected release sites in rangeland areas; (2) planning decisions for Sand Hills State Park and the distribution of work force activities; (3) zoning decisions in response to prime agricultural land analyses; (4) the decision to pursue additional reclamation efforts in strip-mined areas of southeast Kansas. Long-term projects were continued in the past year and include weed pest surveys in cooperation with the Kansas Department of Agriculture and the U.S. Environmental Protection Agency and irrigation data compilation from LANDSAT in cooperation with the Kansas Legislative Research Department.

Other projects were initiated during this period which are now nearing completion or awaiting final action.

I. THE KANSAS APPLIED REMOTE SENSING PROGRAM

INTRODUCTION

The unique contemporary problems facing officials at all levels of government have created a need for objective data gathering to supplement or in some cases replace traditional methodologies. The need for objective data gathering has been further emphasized by the increasing pressures from social, environmental and economic considerations.

The University of Kansas Applied Remote Sensing Program (KARS) has established a continuing program of activities to demonstrate the utility of remote sensing technology in data gathering for decision makers in state, regional and local agencies. Now in its sixth year, the KARS program is developing the concepts and methodologies to utilize remote sensing procedures in dealing with significant problems in Kansas related to changing urbanization patterns, rapid irrigation growth, changing agricultural needs and environmental quality. This activity is accomplished primarily through cooperative remote sensing projects with governmental agencies in Kansas on problems of immediate concern.

This report outlines the activities and accomplishments of the KARS program during the period April 1, 1977, through March 31, 1978 in pursuit of its key objectives:

To apply remote sensing techniques, analysis and systems to the solution of significant decision oriented concerns of state and local officials.

To participate cooperatively on remote sensing projects with state and local agencies in Kansas.

To effect the transfer of applicable remote sensing technology to governmental agencies at all levels as a by-product of the demonstration projects conducted in the KARS program.

To assist the personnel within Kansas agencies in the evaluation of the capabilities of the rapidly changing remote sensing systems and the benefits which might be achieved through their utilization.

Through multidisciplinary teams, to stimulate the application of the products of remote sensing systems to the significant problems of resource management and environmental quality in Kansas.

To guide, assist and stimulate faculty, staff and students in the utilization of information from LANDSAT and Aircraft Programs of NASA in research, education and public service activities carried out at the University of Kansas and in the State.

The interaction which results from these cooperative projects ensures the continued relevancy of the program and maximized the transfer of these new and emerging technological systems to operational use.

CONTACTS WITH AGENCIES

While projects usually develop through individual contacts between agency and KARS personnel, communications also result from more general information dissemination efforts aimed at promoting widespread interest in remote sensing applications. During the past year these activities have included (1) publication of the *KARS Newsletters*, and (2) numerous talks and presentations to public and professional organizations throughout Kansas. These have included, among others, the Kansas Legislative Research Department, the Kansas Department of Economic Development, the Kansas Irrigation and Water Resources Association, the Kansas Academy of Sciences and the Kansas Mapping Conference. In addition, KARS personnel made presentations at the National Conference of State Legistures meeting, the Association of American Geographers Annual Meeting, and the American Society of Photogrammetry Fall Convention.

The quarterly *KARS Newsletter* now reaches over 850 readers with news of current KARS projects and activites (Appendix I). Several new projects have developed from this medium.

There continues to be substantial demand for the Kansas LANDSAT Mosaic, Kansas Land Use Patterns Map published in 1974 and The Guide to Aerial Photography and Space Imagery. These have greatly increased the visibility of the KARS Program across Kansas.

COORDINATION WITH AGENCY OFFICIALS

Experience gained in the KARS Program has demonstrated that it is not sufficient to hold conferences, publish newsletters, or make occasional calls on agency personnel. A continuing association with key administrators and their staffs is carried on to develop their interest,

promote KARS projects, and finally obtain agency commitment of time and resources for the projects.

During the last year we have increased personal visits to Kansas agencies. The visits are facilitating better communications between KARS and agency personnel. Agencies with which contacts have been established are listed in Table 2. Contacts are maintained with all of these agencies and additional contacts actively pursued.

NATURE OF PROJECTS

Table 2 indicates the range of projects completed during FY 75-76. Note in Figure 1 that projects have been distributed widely over Kansas and are particularly relevant to the terrain, land use and specific problems of these areas.

PERSONNEL

The Applications Program is administered by Dean B. G. Barr, Professor of Engineering and Director of the University of Kansas Space Technology Center. Barr, a specialist in engineering management, has been active in transmitting new technologies to industry and state agencies for over ten years.

Dr. Edward A. Martinko, Courtesy Professor of Biological Sciences and Assistant Scientist in the Space Technology Center, is the Project Coordinator for the KARS Program and has primary responsibility for agency contacts, scheduling and the accomplishment of demonstration projects by the joint agency-KARS teams. Dr. Martinko has had several years of experience in multidisciplinary research projects. He was a research assistant in the State Biological Survey of Kansas for two years and has an excellent working relationship with the agricultural community.

During the past year Dr. T. H. Lee Williams, Assistant Professor in the Department of Geography, has joined the KARS staff. He brings expertise with remote sensing platforms and theory to the team with a specialization in agricultural land use studies.

Joseph Poracsky, Ronald Shaklee, Ted Talmon and Vera Sehon carry significant responsibilities in the KARS Program and provide considerable professional expertise in the areas of image interpretation, cartography and data analysis.

Table 1

AGENCIES WITH WHICH CONTACTS ARE MAINTAINED BY THE KANSAS APPLIED REMOTE SENSING PROGRAM

Municipal:

- Concordia, Kansas Chamber of Commerce
- Kansas City, Kansas City Commission
- Kansas City, Kansas Department of Planning and Development
- Kansas City, Kansas Mayor's Office
- Lawrence, Kansas City Engineer
- Lawrence, Kansas City Commission
- Lawrence, Kansas Planning Department
- Salina, Kansas Planning Department

County:

- Cherokee, Kansas Board of Commissioners
- Cloud, Kansas Commissioners
- Douglas, Kansas County Extension Agent
- Douglas, Kansas Planning Department
- Riley, County Engineer

State:

- Kansas Agricultural Extension Service
- Kansas Attorney General's Office
- Kansas Corporation Commission
- Kansas Department of Agriculture
- Kansas Department of Economic Development
- Kansas Department of Health and Environment
- Kansas Department of Revenue
- Kansas Department of State Planning and Research
- Kansas Department of Transportation
- Kansas Department of Energy
- Kansas State Conservation Commission
- Kansas Fish and Game Commission
- Kansas Geological Survey
- Kansas Governor's Office
- Kansas Legislative Research Department
- Kansas Mined Land Conservation & Reclamation Board
- Kansas Parks and Resources Authority
- Kansas Water Resources Board
- Missouri Water Resources Board
- Missouri Department of Natural Resources
- Missouri Governor's Office

Regional:

- Big Lakes Regional Planning Commission (Pottawatomie, Riley, Geary)
- Chikaskia-Indian Hills Regional Planning Commission (Sumner, Harper, Kingman)
- Flint Hills Resource Conservation and Development Project
- Four Rivers Resource Conservation and Development District (Jewell, Republic, Mitchell, Cloud, Ottawa, Lincoln, Ellsworth and Saline Counties, Kansas)
- Greater Southwest Regional Planning Commission
- Groundwater Management Districts
- Mid-America Regional Council
- Northwest Kansas Planning and Development Commission (Cheyenne, Sherman, Wallace, Rawlins, Thomas, Logan, Decatur Sheridan, Gove, Norton, Graham, Trego, Phillips, Rooks, Ellis, Smith, Osborne, and Russell Counties, Kansas)
- Ozark Regional Commission
- Sunflower Resource Conservation and Development District (Sumner, Harper, Kingman, Barber, Comanche, and Kiowa Counties, Kansas)
- Tauy Creek Watershed Planning District Board of Directors
- Missouri River Basin Commission

Federal:

- U.S. Army Corps of Engineers, Kansas City and Albuquerque Offices
- U.S. Department of Agriculture, Soil Conservation Service
- U.S.G.S. Water Resources Division - Lawrence
- U.S. Environmental Protection Agency, Kansas City and Washington, D.C. Offices
- U.S. Fish and Wildlife Service
- U.S. Bureau of Indian Affairs
- National Aeronautics and Space Administration

Table 2

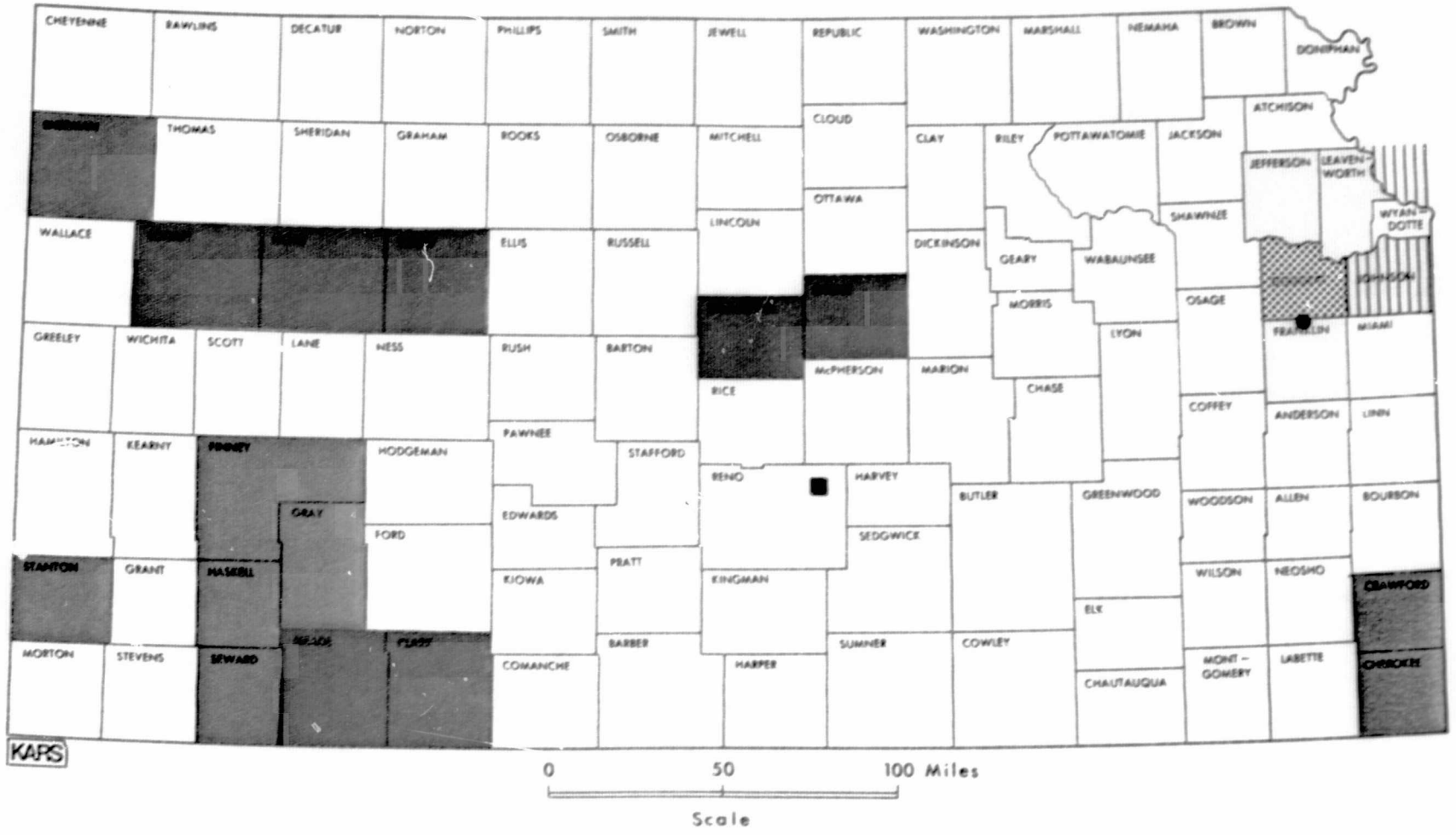
KARS PROGRAM

PROJECTS COMPLETED OR INITIATED

MARCH 1977 - APRIL 1978

PROJECT:	Planning for Sand Hills State Park
COUNTY INVOLVED:	Reno
COOPERATING AGENCY:	State Park and Resources Authority
PROJECT:	Total Irrigation Mapping
COUNTIES INVOLVED:	Sherman, Stanton, Finney, Gray, Haskell, Seward
COOPERATING AGENCY:	State Legislative Research Department
PROJECT:	Tauy Creek Watershed Planning
COUNTIES INVOLVED:	Douglas, Franklin
COOPERATING AGENCIES:	Tauy Creek Watershed Board of Directors, Soil Conservation Service
PROJECT:	Antelope Release Site Analysis
COUNTIES INVOLVED:	Logan, Gove, Trego, Meade, Clark, Ellsworth, Saline
COOPERATING AGENCY:	Kansas Forestry, Fish and Game Commission
PROJECT:	Douglas County Zoning
COUNTY INVOLVED:	Douglas
COOPERATING AGENCY:	Lawrence-Douglas County Planning Department
PROJECT:	Prime Agricultural Land Zoning
COUNTIES INVOLVED:	Johnson, Wyandotte, Leavenworth, Kansas; Platte, Missouri
COOPERATING AGENCY:	Mid-American Regional Council
PROJECT:	Musk Thistle Infestation
COUNTIES INVOLVED:	Leavenworth, Jefferson, Douglas, Johnson, Franklin
COOPERATING AGENCIES:	Kansas Department of Agriculture, Environmental Protection Agency
PROJECT:	Strip Mine Reclamation
COUNTIES INVOLVED:	Cherokee, Crawford
COOPERATING AGENCY:	Kansas Forestry, Fish and Game Commission

REMOTE SENSING APPLICATIONS PROJECTS



Antelope Release Sites

Total Irrigation Mapping

Tauy Creek Watershed

Douglas County Zoning

Prime Agricultural Land Zoning

Musk Thistle Infestation

Strip Mine Reclamation

Sand Hills State Park

April, 1977 - March, 1978

Figure 1.

Projects requiring major scientific effort are staffed primarily by graduate students from the various academic disciplines assisted by faculty advisors when appropriate. Personnel from the various state and local agencies are involved in their own applications projects at no cost to the NASA grant. We continue to work with the various extension agencies in the state to gain their assistance in translating remote sensing technology to a broader audience.

FACILITIES

The KARS laboratory located on the second floor of the KU Space Technology Center serves as the headquarters of the Kansas Applied Remote Sensing Program. Light tables, a Bausch and Lomb Zoom Transfer Scope and other equipment needed by the KARS team have been provided by the Space Technology Center for the demonstration projects. In-house graphic arts and photo services facilities offer complete cartographic and film processing services. Computation services are available both in-house and through a remote terminal to the University Computation Center.

The KARS Program has several types of equipment in its laboratory to aid in the interpretation of remotely sensed images. An Itek Color Additive Viewer/Printer (ACVP) has the ability to enlarge, superimpose, and register up to four separate black and white transparencies for viewing, printing, or color enhancement. Both LANDSAT imagery and aerial photography in 70 mm formats can be accommodated. In addition to the ACVP the KARS Program has a Variscan Rear Screen Variable Magnification Viewer. This instrument is capable of rear projection of film transparencies of any size from 35 mm to 9½ inches in format at several enlargements up to approximately 48 times the original scale. Together these instruments complement the optical equipment in the KARS Program laboratory and expedite more involved interpretations and image analysis.

Procedures have also been established for more efficiently producing quality products for agency use. These procedures include mapping on stable base materials in negative mode and using color preseparation overlays to display data. This allows the user to separate the interpretation categories into individual displays, provides for inexpensive multiple copy reproduction, and increases the possibility that the material can be used by more than one agency.

A current file of LANDSAT, Skylab and aerial imagery is maintained in the KARS laboratory for the use of project personnel and user agencies. The LANDSAT file contains the best quality imagery for specific time periods during the year. The imagery is catalogued in an accessible file providing complete coverage of Kansas.

The KARS Program also maintains a substantial reference library for both in-house and agency use. This material includes reports, articles, periodicals, manuals, text books, etc., pertinent to applications of remote sensing.

Using LANDSAT to Select a Pronghorn Antelope Release Site in Kansas

Pronghorn antelope once flourished on the Kansas prairies. But as their native habitat declined, giving way to agricultural production, their numbers dwindled and the pronghorn populations were reduced to a few remenant herds located in isolated areas of the state. Although commonly referred to as an antelope, the pronghorn is a member of a separate family, Antilocapridae. Found only in North America, they are the continent's swiftest mammal capable of speeds approaching 60 miles per hour. It has a deer-like build and averages between 100 and 140 pounds in size as a mature adult. Both sexes have white rump patches which they flash when startled or in danger. The pronghorn is unique in several other respects. It is the only horned animal that sheds its horns, although it retains a core, and is the only horned animal with branched or prong horns, from which its name is derived. To some degree, they have a beneficial effect on that rangeland that is also used for cattle grazing. Pronghorn eat many types of vegetation eschewed by cattle such as sagebrush, forbs and cacti, thereby creating a better vegetation balance for cattle grazing purposes.

The Kansas Fish and Game Commission has undertaken a project to re-introduce pronghorn antelope to the Kansas Prairie. This program began in 1964 when KF&G successfully transplanted 75 pronghorns from the National Bison Range in western Montana to an area in Sherman and Wallace counties in extreme northwest Kansas. Later that year another 61 pronghorn were trapped in Colorado for release in Barber County in the southcentral part of the state.

To monitor the transplanted pronghorn populations, the KF&G has used aerial surveys to compile population estimates. These surveys are taken during the winter months when the pronghorn congregate into herds of 25 to 30 animals. As of January 1977 the pronghorn population in northwest Kansas was estimated at 1,100 animals on 250,000 acres of contiguous rangeland bordering the Smoky Hill River. This represented an annual overall increase of over 20% since 1969. The Barber and Comanche County

pronghorn population has been far less prolific with estimates of between 50 and 100 animals in that region. However, accurate estimates of the pronghorn populations in this area have been hampered by the rugged terrain.

As a result of the dramatic increase of pronghorn populations since 1964, particularly in the northwest Kansas herd, the KF&G issued hunting permits for the first time in 1974. Over 500 hunters responded with requests for permits and KF&G employed a lottery system in determining the recipients for the 80 permits that were issued. Due to the number of permit requests and the success of the established herds, the KF&G began to consider the possibility of stocking other areas of Kansas with pronghorns.

In selecting potential release sites for additional pronghorn transplants, KF&G personnel looked for areas featuring large tracts of uninterrupted rangeland with adjacent wheat fields. Very few areas were found which met these basic requirements and which were thought to be capable of supporting herds of 50 or more pronghorn. Five areas were identified as potential release sites. These were: Morton County in extreme southwest Kansas and the site of the Kansas-Cimarron National Grasslands; Barber, Kiowa, Commanche and Clark counties in the southcentral part of the state; Gove, Logan and Trego counties in northwest Kansas which are adjacent to existing herds; Lincoln, Saline and Ellsworth counties in central Kansas; and finally, the Flint Hills region in eastern Kansas.

In August 1977, the Kansas Fish and Game Commission contacted the KARS program to evalute the possibility of using remotely sensed data in determining pronghorn habitat conditions in these potential release sites. Subsequently, KARS staff and KF&G personnel analyzed the pronghorn habitat sites using the Kansas Land Use Patterns map prepared by KARS in 1974 and current KF&G field data. A plan was approved by KF&G for the capture of 100 pronghorn in Wyoming followed by the release of 50 animals each in two selected release areas in Kansas. Five potential release sites were established: 1) Clark County area, 2) Morton County, 3) Gove County area, 4) Flint Hills region and 5) Ellsworth County area. The Flint Hills region in eastcentral Kansas was initially selected for one of two release sites of 50 pronghorn. KF&G personnel selected three other potential release sites based on proximity to the established 1964 herds and field observations:

1) the Gove County area, 2) Clark County area, and 3) Ellsworth County area. This eliminated the Morton County area from further consideration.

Realizing that some 80% of the land cover in Kansas is used for agriculture, KF&G personnel were quite interested in maps of increases of agricultural land onto rangeland in the three study sites. KARS personnel suggested that LANDSAT data for 1972 through 1976 would provide information on agricultural trends for the three sites.

LANDSAT data was acquired for the three potential release sites in a 1:500,000 black and white print format. Imagery between May and September of the years 1972 through 1976 were used to interpret agriculture enroachment onto rangeland. Four LANDSAT images were interpreted for each year. Statistical data was provided to the KF&G personnel for evaluation of the final release site, Table 3.

Table 3

Clark County Site

Study Site 577,128 acres (233,561 ha)

1972 Agriculture 219,050 acres (88,648 ha) Rangeland 358,078 acres (144,912 ha)

	Rangeland converted to Agricultural land	% Change
1973	2,647 acres (1,071 ha)	.7
1974	7,239 acres (2,930 ha)	2.0
1975	2,802 acres (1,134 ha)	.8
1976	3,736 acres (1,512 ha)	1.0

Ellsworth County Site

Study Site 472,633 acres (191,272 ha)

1972 Agriculture 278,911 acres (112,874 ha) Rangeland 192,752 acres (78,410 ha)

	Rangeland converted to Agricultural land	% Change
1973	3,659 acres (1,481 ha)	1.9
1974	4,048 acres (1,638 ha)	2.1
1975	4,515 acres (1,827 ha)	2.3
1976	2,413 acres (977 ha)	1.3

Gove County Area

Study Site 742,155 acres (300,346 ha)

1972 Agriculture 403,616 acres (163,341 ha)

	Rangeland converted to Agricultural land	% Change
1973	76,675 acres (31,030 ha)	22.7
1974	16,736 acres (6,773 ha)	5.0
1975	13,545 acres (5,482 ha)	4.0
1976	17,203 acres (6,962 ha)	5.1

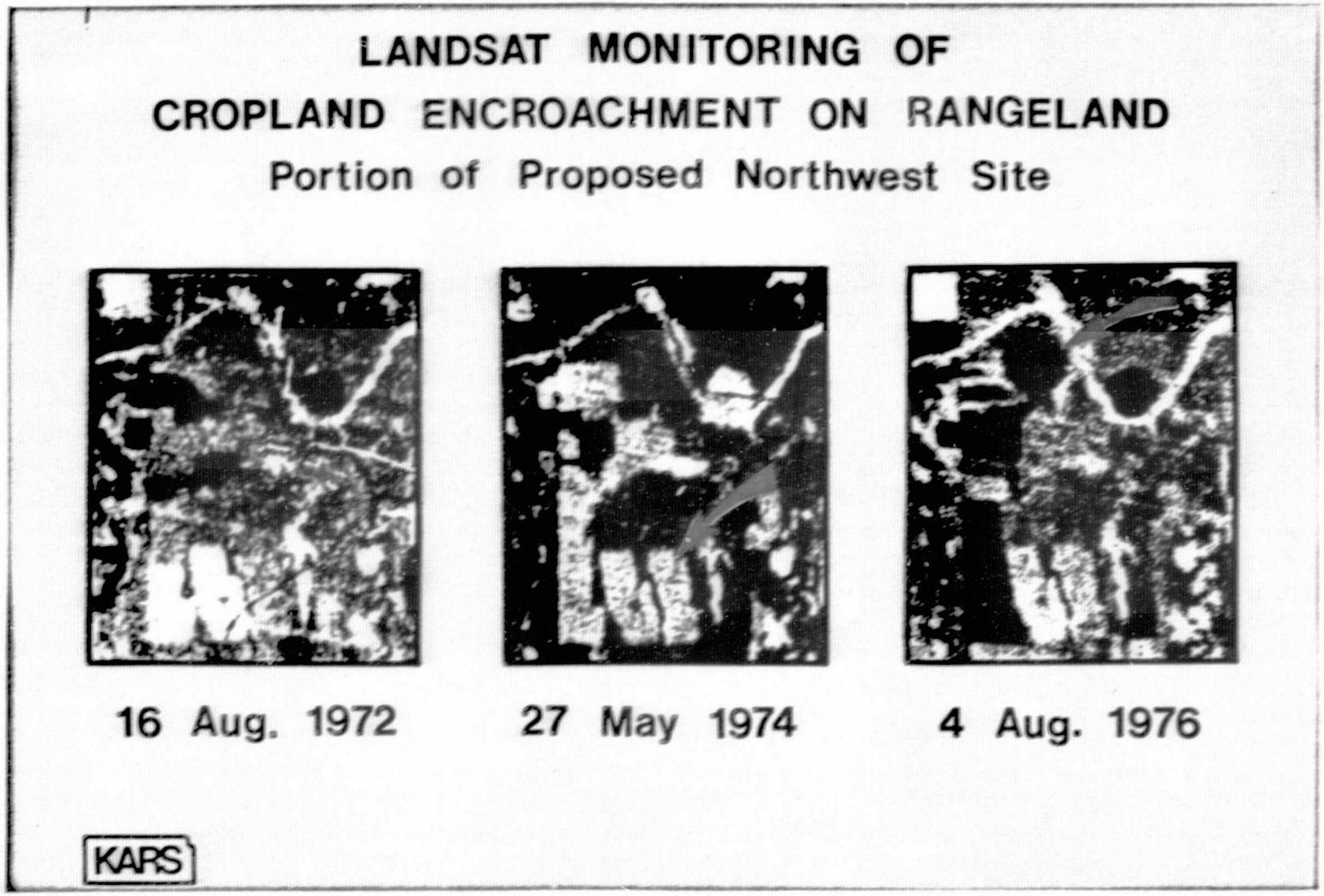


Figure 2.

Figure 3. Pronghorn capture in Wyoming for transport to Kansas rangeland areas. Pronghorn are herded by helicopter into the awaiting trap.

This analysis of the LANDSAT data provided the KF&G with essential information on each of the sites. Of particular importance was the data on the Gove County area. Based upon its location and general area the KF&G had anticipated that this area would be selected as the second release site. The LANDSAT analysis showed that the Gove County area had experienced a 37% decline in rangeland over the five year period between 1972 and 1976. This was judged to be unacceptable by KF&G officials who instead selected the Clark County area, which featured an average annual loss of rangeland of only 1%, as the final release site.

In January 1978 KF&G personnel secured permission from the state of Wyoming to trap excess pronghorn populations in that state. A total of 100 antelope were taken and returned to the Kansas release sites with 63 of the pronghorn going to the Clark County site. The remaining 37 pronghorns were released at the Flint Hills location. KF&G officials have recommended that the KARS program be awarded funds to continue monitoring the pronghorn habitat sites every three to five years and to conduct a similar study on the present pronghorn range in Wallace and Sherman counties in northwest Kansas. Pronghorn may eventually be introduced into other areas when determined suitable by KF&G personnel. Through the cooperative efforts of KARS and KF&G, LANDSAT data is making a continuing contribution to the reintroduction of this unique North American big game animal in Kansas.

Reclamation of Mined Land for Fish and Wildlife Areas in Southeast Kansas: Kansas Fish & Game Commission

For a number of years southeast Kansas has been the site of intensive coal mining activity. Most of this activity employed strip mining techniques which left large tracts of land in relatively unusable conditions. Between 1926 and 1969 the state of Kansas acquired 26 tracts of former strip mined lands in Crawford and Cherokee counties with a total surface area of over 6000 acres. These tracts had 90% to 95% of their surface area covered by strip mine dumps and were acquired by the state as donations or at the cost of $1.00 per tract. The area has since been assigned to the Kansas Fish and Game Commission for management purposes and has been designated as the Mined Land Fish and Wildlife Area (MLFWA).

The MLFWA is best described as a series of parallel ridges of dis-associated materials composed of topsoil, subsoil and parent materials. Heights of mine dumps from trough to ridge vary from 3 to 17 meters (10 to 50 feet) depending on when it was mined and on the equipment used. Most of the parent material is clay-shale and limestone with some sand-stone and alkaline shale. Mine dumps are low in fertility and moisture content. In general, organic matter is low, phosphorus levels are low to medium and potassium levels are medium to high. Eastern-most areas of the MLFWA have the lowest pH readings (4.0-5.5), whereas those further west may have readings of neutral (pH 7.) or higher. Few areas are homogeneous; most have highly acid areas only a few meters from neutral spoils. Tracts of unmined land totaling approximately 520 acres occur on 18 tracts of the MLFWA. The three primary soil types that occur in the area, Parsons, Dennis and Helpler, are all poorly drained, acidic and low in fertility.

A detailed description of the area's vegetative characteristics is difficult due to the wide amount of variation between each land tract. Because of successive mining dates and variation in vegetation types intro-duced by man, the vegetation of the area is characterized by a number of different stages of plant invasion and succession. The normal succession sequence is a progression from annual weeds and grasses, to perennial weeds and grasses with such woody species as blackberry, sumac, cottonwood, osage orange, willow and buck brush, to a final wooded stage designated by cottonwood, elms, willows, oaks, wild cherry, walnut, hickory, locusts and other trees and shrubs.

Surface waters composed of strip-mine lakes and ponds total 896 acres and comprise 14% of the total acreage of the MLFWA. Along the edge of the strip-mined tract is an excavated trough which may be one mile or more in length. These terminal "pits" are 40 to 45 feet deep and approximately 200 feet wide. Roads over which the coal was hauled in large trucks usually run at nearly right angles to the ridges. These roads sometimes join the terminal excavation forming fingers from the major excavated trough. It is the terminal excavation and the haul roads that form the larger bodies of water after the mining ceases. Smaller fingers of water and isolated ponds form in the valleys between the spoil ridges

and in smaller lakes and ponds created where mining equipment deviated from the normal parallel strip-mining course.

Strip-mine waters exhibit a wide variation in water chemistry. The chemical characteristics of each body of water are the results of the geologic composition of the different mined coal beds and the type of equipment and stripping technique used in the mining process. Sulfur and iron bearing minerals such as pyrite and marcasite occur in quantity in some coal strata. These impurities, when removed from the coal in the washing process, are concentrated into spoil piles called "tipples". Left to weather, these compounds react with water and oxygen to form iron sulfate and sulfuric acid. As a result sulfates comprise the greatest proportion of all elements and ions found in mined land waters. Shales and clays associated with the coal beds may also contribute to sulfate concentration in addition to contributing high quantities of iron, aluminum and manganese.

Thermal stratification is characteristic of most strip-mine lakes increasing in complexity from acidic to alkaline waters with greater depths. Turbidity of mined land waters is also quite variable and is related to the water's pH. Extremely clear waters are the rule; however, alkaline waters may have the appearance of normal waters and maintain a transparency of 30 cm. to 100 cm. (12 to 36 inches) depending upon the presence and density of planktonic organisms.

Present fish populations are the combined result of several different sources. These include self stocking from adjacent streams during periods of heavy runoff; public stockings by "well-meaning" fishermen; and the official efforts of state and federal fish hatcheries. Hatchery fish are stocked in newly-mined alkaline and chemically reclaimed strip-mine lakes. Fish which are regularly stocked in these waters include largemouth bass, bluegill, channel catfish and walleye. Stockings with northern pike, brown bullhead, flathead catfish, rock bass, black crappie, striped bass and trout have been made periodically.

The cottontail rabbit, mourning dove, bobwhite quail and fox squirrel are the primary game animals. There are some areas that have a good deer population and some areas have a fair population of fur-bearing animals. The area has little waterfowl value.

In 1962 the Kansas Fish and Game Commission began an intensive program of management designed to enhance the fish and wildlife resources of these areas. The development and management of the area for fish and wildlife presents unique problems for the KF&G Commission because of the size and expanse of the area, and the configuration of the land and water as a result of the coal mining. KF&G commission personnel requested the aid of the Kansas Applied Remote Sensing Program (KARS) in providing color-infrared aerial (low altitude) photography of the area to assist managers in planning for future development and management, and to insure maximum benefits for the hunters and fishermen.

The Kansas Applied Remote Sensing Program agreed to provide KF&G personnel with 1:18,000 scale color infrared photographs of the area which were subsequently acquired in June 1976. Due to the size of the study area and the intensity of the interpretation effort, it was agreed that the bulk of the interpretation and mapping effort would be performed by KF&G personnel. The KARS program agreed to an active role in the analysis of sample areas as a training effort for the KF&G personnel who would be responsible for carrying out the remaining interpretation task.

This training program focused on three primary interpretation tasks: the interpretation and analysis of the health and intensity of existing ground cover; the detection and delineation of standing water bodies; and the detection and delineation of drainage patterns. The training effort was facilitated by the KF&G personnel's prior knowledge of the area's surface situation. These interpretation tasks were tailored to the data needs of the KF&G management personnel and were directly related to specific reclamation activities that were being planned at the time.

One of the most important areas of concern was the relationship between strip-mine lakes and the drainage patterns associated with the discharge and recharge of waters in the lakes. This association plays an important role in planning rehabilitation efforts for the lakes. The aerial photography was used to perform a drainage pattern analysis that allowed KF&G personnel to locate areas where small dams could be placed as a mechanism for controlling water movement. This eliminated the migration of polluted waters into the lakes, thereby stabilizing water quality conditions and facilitating treatment activities.

This same drainage pattern analysis was used to determine fish migration patterns. This enabled KF&G personnel to plan a program of treatment which used fish toxicants to eliminate undesirable fish species and prevent their re-entry to controlled lakes and waters.

The second important area of concern involved the vegetation cover, both for its wildlife habitat value and as an indicator of soil quality in the reclaimed areas. Bare areas were easily detected from the aerial photography and indicated areas of acidic soils and unreclaimed tipple sites. These areas are sources of continuing pollution and are the primary focus of reclamation activity. In this respect, particular attention was given to a 144 acre tract that had been the subject of a $40,000 reclamation program. The aerial photography showed the reclamation effort deficient in several areas. The vegetation cover was sparse in several areas which contributed continued erosion problems, overburden areas had not been adequately excavated and temporary pools of standing water were detected which had created additional drainage problems. Based on this information, KF&G personnel requested an additional $11,000 to correct these deficiencies and thus protect the investment embodied in the original $40,000 reclamation effort.

The final use of the aerial photography involved the analysis of health vegetation areas for their wildlife habitat value and in the evaluation of the effectiveness of different habitat manipulation efforts (i.e., prescribed burning, herbaceous seeding, etc.). While these manipulation programs have been pursued with known results in other areas, a re-evaluation of their effects was necessary in the strip-mined areas which feature different soil, moisture and drainage conditions than would be found in undisturbed areas.

The aerial photography was used to demonstrate to KF&G administrative personnel the problems associated with the reclamation effort. As a result the administration has decided to increase the annual reclamation budget to $20,000 per year. The effectiveness of the photography in the assessment of these reclamation problems in the MLFWA has fostered similar activities in other KF&G reclamation projects.

Based upon the interpretation of the 1976 imagery, several small earthen dams have been planned for construction in 1978 to begin the pollution control effort. Other areas will be treated with slope control measures, acidic soils will be covered with non-acidic spoil material followed by an application of lime and the planting of low pH resistant forbs and grasses to reduce acid-mine drainage into streams and lakes.

The photography has been used to identify suitable locations for access trails, boat ramps and potential areas for the planting of stands of native grasses, forbs and shrubs to improve wildlife habitat. The improved access trails are planned for 1978 construction and will benefit sportsmen and KF&G management specialists in their continued effort to upgrade the conditions of what was once considered useless parcels of land.

URBAN AND REGIONAL PLANNING

Prime Agricultural Land Zoning

In August 1974, the Mid-America Regional Council (MARC) received a report entitled A Soil Guide for the Kansas City Region, which was a comprehensive analysis of the soils and soil patterns for the eight county MARC region. This study was conducted by soil scientists from the U.S. Department of Agriculture and the University of Missouri as part of the National Cooperative Soil Survey and included an in-depth analysis and description of the soils in Johnson, Wyandotte and Leavenworth counties in Kansas and Ray, Platte, Clay, Cass and Jackson counties in Missouri. One of the stated objectives of the soils guide was that it be used as an aid by those persons charged with making land use decisions within the Kansas City Metropolitan Region. As such, the guide included an interpretative analysis of the soils and their capabilities for supporting seventeen different land use activities. An accompanying map delineated those areas which were considered to have potential as prime agricultural land and was subdivided into areas of prime agricultural upland and prime agricultural lowland to reflect the different capabilities associated with similar soils in these two categories. Urban and agricultural land uses are the two major competitors for land resources within the region and MARC officials felt that a comparative study was needed to determine the degree to which urban development was affecting the agricultural land resources of the region. KARS personnel suggested that this type of comparative study could best be done with remotely sensed data. A survey of available imagery covering the MARC region showed that two NASA high altitude missions flown in 1969 and 1974 would allow both an assessment of the current status of urban development and agricultural land and a multiple year study to show the rate at which urban expansion was encroaching upon prime agricultural land.

PROCEDURES

The primary objective of the study was to provide an assessment of the amount of prime agricultural land which had been converted to urban land uses, with a secondary concern over the rate at which this process

occurred during the five year period between 1969 and 1974. Two supplemental sources of imagery were required to offset coverage deficiencies in the two high altitude flights that were intended as the major sources of urban development information. NASA flight #RB-106 flown on October 2, 1969, was the main source for data acquired for the 1969 time period. Since this flight did not completely cover Ray County, an additional source of information, ASCS Photo Index Sheets #BS 29177 sheets 1 and 3 acquired in 1970, were used as a data base for the eastern half of Ray County. The NASA flight #74-077 from May 15, 1974, was used for the bulk of the 1974 data. For 1975 deficient coverage of the eastern portion of the MARC region was insufficient and required that a supplementary data source be used. In this case, NASA flight #75-300 acquired on February 6, 1975, provided the information for all of Ray County and minor portions of Cass, Clay and Jackson Counties. Color infrared imagery was used for the interpretation of urban land use activities for each of the NASA flights, along with ASCS photo index sheets consisting of black and white imagery that had been acquired at medium altitudes.

The interpretation of urban and built-up land included a variety of land use activities not generally associated with the urban category. The use of the term "urban land use" throughout the study was a reflection of these collective land use activities in the following definition:

> Urban land use as defined in this study refers to those land use activities which either temporarily or permanently remove land resources from potential agricultural production due to human related development. This includes the commercial, residential and industrial development usually associated with the urban category as well as military reservations, transportation networks, recreational areas, quarrying activities and septic lagoons.

Using this broad category of urban land use, interpretation and mapping proceeded using 1:125,000 scale county road maps as a mapping base. Using a Bausch and Lomb Zoom Transfer Scope, the high altitude imagery was superimposed upon the base maps thereby allowing concurrent interpretation and mapping of the size and location of developed areas. The high altitude imagery was acquired at a scale varying from 1:120,000 to 1:130,000 and the interpretation was consequently done on approximately a 1:1 basis with

minor changes to account for scale variations. Urban land uses were first interpreted and mapped using the 1969 imagery for each county. The 1974 imagery was then compared to these maps to detect those areas where expansion had occurred.

The urban growth data generated from the imagery were then compared to prime agricultural land maps of the region which had been compiled as a part of the National Cooperative Soil Survey to show those areas where urban development had occurred upon land classified as having prime agricultural potential.

The final phase of the study involved the compilation of area statistics for the categories appearing on the final map. Using a Hewlett-Packard 9100B programmable calculator with an area digitizer, acreage estimates were acquired for each of the fifteen categories listed below.

A. Total Area
B. Total Prime Agricultural Land
    1. Total Prime Agricultural Upland
    2. Total Prime Agricultural Lowland
C. Total Marginal Agricultural Land and Other Land
D. Total Urban Area 1969
    1. Developed Prime Agricultural Land
        a. Developed Prime Agricultural Lowland
        b. Developed Prime Agricultural Upland
    2. Developed Marginal Agricultural Land and Other Land
E. Total Urban Area 1974
    1. Developed Prime Agricultural Land
        a. Developed Prime Agricultural Lowland
        b. Developed Prime Agricultural Upland
    2. Developed Marginal Agricultural Land and Other Land

RESULTS AND ANALYSIS

The MARC Region covers an area of approximately 2,480,525 acres with 48.5% of this area (1,203,584 acres) falling within the classification of prime agricultural land. The prime agricultural uplands account for 725,388 acres of the prime agricultural land area and represents 60.3% of the prime agricultural land resources. Prime agricultural lowlands account

for remaining acreage of this category with 1,276,941 acres of land being classified as either marginally suited for agriculture or unsuited for agriculture.

From the 1969 imagery a total of 227,484 acres of land were interpreted as urban land or 9.2% of the total land area within the MARC region. Of this total, 83,632 acres of prime agricultural land had been converted to urban land uses representing 36.8% of the entire urban area and 6.9% of the region's agricultural land resources.

The development which occurred between 1969 and 1974 amounted to 26,418 acres of land area, with 11,682 acres (44.2%) of this new development located upon prime agricultural land. The percentage of the total land area utilized for urban land uses increased to 10.2% during this period. The prime agricultural land converted to urban land uses during this time period brought that total to 95,314 acres for the region and increased the percentage of developed prime agricultural land to 7.9% of the total agricultural land resources.

The patterns formed by the prime agricultural land areas within and immediately adjacent to the Kansas City Metropolitan Area have affected both the historical and current patterns of development with respect to their disturbance of prime agricultural land resources. One example is the original site location of Kansas City where initial settlement required the use of prime agricultural lowlands bordering the rivers. As a result of such development a sizable proportion of the prime agricultural land listed as converted to urban land uses is simply a reflection of the early expansion of the city along and away from the river banks.

A transitional zone between the prime agricultural lowlands and prime agricultural uplands which consisted of sloping lands not suited to the prime agricultural definition was the site of development following the city's growth beyond the bottomlands immediately adjacent to the rivers. This development has served to decrease the frequency with which urban land uses would have occupied prime agricultural lands, with a major portion of the Kansas City Metropolitan Area being located in a non-agricultural triangle bordered by the bottomlands of Mill Creek and the Blue, Kansas and Missouri Rivers. The current development upon prime agricultural land areas reflects the city's growth beyond these transitional

zones and onto the prime agricultural uplands which are now bounding the city with increasing frequency.

The Kansas City Metropolitan Area itself is centered in the eight county region with portions of four interior counties serving as the primary location for development. Together Jackson, Johnson, Wyandotte and Clay counties account for 85.3% of the urban related development with the MARC Region with Jackson County alone containing 39.5% of the region's urban area. Beyond this core area urban development generally consists of distinct communities which are geographically removed from the general metropolitan area. While the urban development in the outer tier counties tends to occur with more frequency upon prime agricultural land, the historical function of these cities as service areas to an agricultural population dictate a proximity to agricultural activity and hence increase the probability of these cities being located upon prime agricultural land. Subsequent growth of these cities has thus tended to reflect this historical situation. An analysis was then made for each county in the MARC Region with respect to the amount of available prime agricultural land and the effects which urban development had upon the county's prime agricultural land resources. These statistical analyses and comparisons were compiled for the combined data and the findings were submitted to MARC in May, 1976 for evaluation and study. MARC distributed the findings of the report to individual member governments for consideration and developed policy guidelines for future urban expansion at this urban/rural fringe. That policy recommended that all future development be designed to minimize the impact of development upon agricultural production in rural areas and urged member governments to employ protective measures in planning activities in rural areas to protect remaining supplies of agricultural land within the region.

One of the first units of local government to respond to the report was the city of Kansas City, Missouri. The city was experiencing a great deal of residential growth pressure towards Kansas City International Airport and in an effort to curb this growth responded by designating lands around the airport as industrially zoned areas. The city did not have an effective agricultural zoning classification and employed the industrial zoning as a means of preventing residential growth. The city currently features an overabundance of industrially zoned area and the lack of

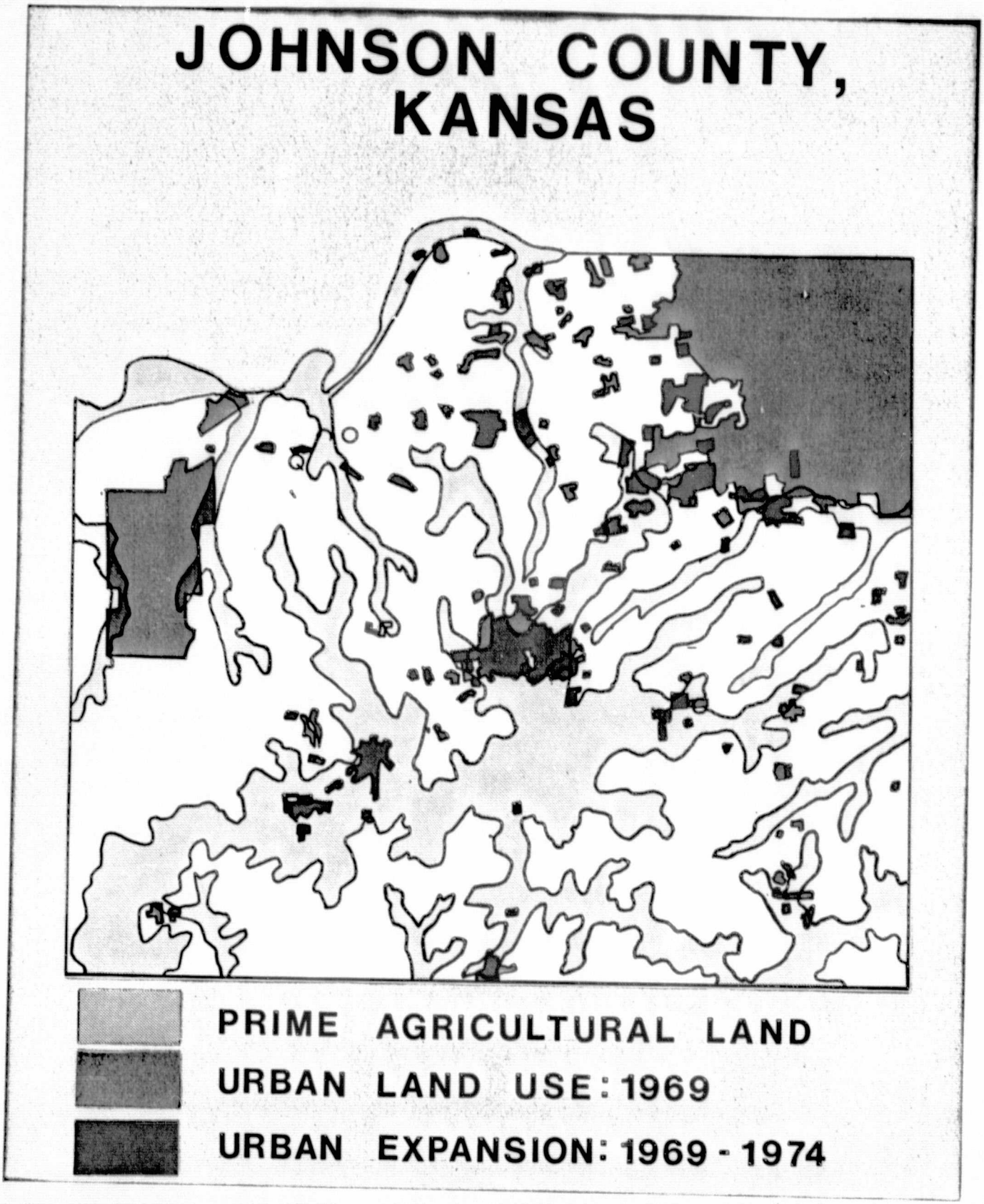


Figure 4. Prime agricultural land conversion in Johnson County, Kansas.

demand for land in an industrial capacity insures the continued use of the airport lands in an agricultural capacity.

Johnson County, Kansas used the report to show that the county is in no immediate danger with respect to its agricultural land resources. For the most part agricultural land in the county is remotely located with respect to the county's urban centers and is in no immediate threat from development.

Wyandotte County, Kansas is one of the most densely populated areas in the state and responded to the report in a negative manner. The amount of agriculturally productive land in the county has been greatly reduced and the development of policy protecting those remaining lands was subjugated to a level of lessor importance.

Lawrence-Douglas County Zoning Decisions

Since its inception the KARS Program has worked closely with the Lawrence-Douglas County Planning Department, Planning Commission and County Commissioners in providing resource assessments and evaluations for the Lawrence-Douglas County area. The area is one of the fastest growth areas in the State and is expected to be subjected to increased growth pressure as a result of the recent completion of the Clinton Reservoir.

County officials have been concerned with these growth projections and have responded through the development of planning mechanisms to contend with current growth pressure and to act as a blueprint for future planning officials in contending with similar growth situations. Two documents have evolved as a result of these planning efforts, both of which rely heavily upon KARS supplied data as the foundation for planning strategies.

The first document to be developed using KARS data was the Clinton Reservoir Area Mini-Comprehensive Plan which addressed the more immediate concern of development associated with the reservoir. KARS input to this document involved the assessment of existing land use and land cover; evaluation of the scenic value of lands adjacent to the reservoir area;

evaluation of transportation networks in the area; and an assessment of land potential. Planning officials used this data to devise an area-wide plan for future development by assigning zoning classifications to lands within the affected area.

Two major policy recommendations were derived from the plan which have served as guidelines to the planning commission and which have directly influenced subsequent zoning actions. The first policy to be developed involved the restriction of rezoning issues associated with rural development. In essence, the commissioners decided that no land zoned for agricultural use would be approved for rezoning to a rural residential subdivision zoning classification. A second policy was developed placing similar restrictions on requests for commercial rezoning for any land not originally given a commercial classification.

As a result of these policy declarations, six zoning actions have been considered by the planning commission and the requests for rezoning denied. Two of these cases involved requests by developers for residential subdivision zoning on lands zoned for agricultural use. The four remaining cases involved requests for commercial zoning on lands outside of designated commercial areas. The zoning issue culminated with the declaration of a temporary moratorium on all zoning actions associated with development of the Clinton Reservoir. In addition to the zoning actions, the county commissioners have elicited a promise from the Corps of Engineers that the development of Corps owned areas will comply with the area-wide goals and intent of development as outliend in the Clinton Reservoir Area Mini-Comprehensive Plan.

In 1975 planning officials began preparations for compiling a comprehensive plan for the entire county similar to the plan that had previously been compiled for that portion of the county involved in the Clinton Reservoir area. This plan, entitled Plan 95, was to be designed to act as a guide for all planning activity within the county for a twenty year period (1975-1995) balancing projected growth needs and requirements against existing land uses and land capabilities.

Officials again contacted the KARS program requesting support for the Plan 95 comparable to the same support that was given in the Clinton Reservoir planning effort. The KARS Program and the Center for Research,

Inc. (CRINC) entered into a contractual agreement with county officials in which CRINC agreed to supply the appropriate aerial photographic coverage of the county with the KARS Program providing a county-wide assessment of existing land resources and land uses. Standard imagery interpretation techniques were employed in analyzing the 1:24,000 scale black and white photographs. Maps keyed to 1:24,000 scale U.S.G.S. topographic sheets were compiled showing the required information elements desired by county representatives. These maps were then supplied to the appropriate county representatives at the conclusion of the interpretation and mapping process.

This data was then used in the assessment of the current status of land use, and planning philosophies were developed which would minimize the impact of expected growth patterns on present patterns of land use within the county. While this document is in the process of being prepared for publication, the data has already been put to active use by planning officials in a decision-making capacity.

The first decision involved an analysis by KARS personnel of seven proposed building sites for medical office buildings. The Planning Commission had been presented with numerous proposals for the development of these facilities following the completion of the Lawrence Memorial Hospital complex, and hospital administrators had indicated a need for additional support facilities in the general area of the hospital. The Lawrence-Douglas County Planning Department had selected seven possible sites for development and requested KARS assistance in an analysis of existing surface conditions at each of the proposed sites. The same imagery was used that had been acquired for the general county mapping effort and for each site a map was compiled to show existing structures; their use in a residential, commercial or service capacity; the occupancy status of each structure; and associated outbuildings or other facilities. Each site was then ranked with respect to its development potential as a function of its distance from the hospital, displacement of current residents or building occupants and general impact upon the adjacent residential area.

The Planning Commission subsequently approved two of the sites for development and instituted a moratorium on any additional development of

medical office facilities in the immediate area. This action was taken to preserve the residential character of the neighborhood which would have been threatened by any additional non-residential development.

One final decision was made with this data that involved the site analysis for a proposed new city office complex. Currently, city offices are located in rental facilities and city business is hampered by access and communications problems in its present location. A site analysis was made for a proposed location with the result being that the city has since acquired the site and is now in the process of formulating construction plans for a 3 million dollar office complex at the site.

Mapping and Monitoring Musk Thistle Infestations of Kansas Rangeland

Musk thistle (Carduus nutans) is an aggressive weed that was introduced to the United States from Europe about 125 years ago. Since that time it has become a serious pest of crop, range and pastureland throughout the United States. In Kansas and Nebraska musk thistle has been declared a noxious weed by the legislatures of both states because of the extensive infestations that are presently in excess of one million acres in each state.

The presence of musk thistle in cropland such as alfalfa and wheat is a serious problem particularly in newly seeded areas and in fields which have become senile. Not only does musk thistle reduce the quality of these crops, but it also makes harvesting difficult. This aggressive, unpalatable weed also infests range and pastureland where it reduces the available forage because of its robust, spiney growth form.

The national extent and severity of the problem has been documented and the results indicate that economic infestations are found in 30 of the 48 mainland states. The large extent of this problem together with its most effective control measure, namely the herbicide 2-4 Dichlorophenoxyacetic (2-4 D) acid at a rate of 2 lbs. acid equivalent per acre, emphasizes the considerable pesticide usage.

In spite of the extensive pesticide control program, its success has been limited. A major factor in this lack of success has been the inability to consistently locate large infestations through present survey methods. Secondly, there is no objective procedure currently available for evaluating and monitoring the success of control procedures. Further, although aspects of musk thistle biology are known, information regarding the factors influencing the successful invasion of cropland and rangeland are largely unknown, especially as these relate to the reduction of pesticide load through more efficient application of herbicide or alternate methods of control. Therefore, if truly satisfactory control of musk thistle is to be achieved, a better knowledge of its biology and distribution is necessary.

Because of these various needs, the KARS program initiated a pilot study in cooperation with the Weed and Pesticide Division of the Kansas Department of Agriculture to determine the potential of detecting musk thistle infestations with remote sensing procedures.

Initial studies were based on the distinctive phenology of musk thistle. This species is a biennial, which overwinters in the actively growing rosette stage. It was therefore hypothesized that it might be detectable on early spring imagery since most other vegetation is dead or dormant at this time. Accordingly, a six mile transect in southeastern Marshall County, Kansas, containing known musk thistle infestations was flown on 1 April 1976. Four films (black and white panchromatic, black and white infrared, natural color, and color infrared) at three acquisition scales (1:15,000; 1:24,000; 1:42,000) were employed. Detection results were negative for all film and filter combinations at all scales.

The second attempt at detection took place on 13 June 1976. Musk thistle flowers quite synchronously in this area during mid-June, and it was felt that the distinctive hue produced by the purple flowers might provide a mechanism for differentiating it from the surrounding vegetation. Three fields in Douglas County, Kansas were flown using five film filter combinations (black and white-red band, black and white-green band, black and white-infrared, natural color, and color infrared) at three acquisition scales (1:4,000; 1:7,500; 1:15,000). Here results were more rewarding. Detection was possible at all scales and with all film-filter combinations. Musk thistle was particularly distinctive on the two color films, showing a pinkish tinge on natural color and mustard color on color infrared. Further, areas less than 0.1 acres in extent were visible at 1:15,000 scale. This is particularly encouraging in that economically important infestations range upwards of 10 acres (in some cases 70 acres or more) and may therefore be detectable in the flowering stage at very small scales. Further, evaluation of the multiband black and white imagery (red, green and infrared bands) suggested that the flowering stage has a distinct spectral signature and might, therefore, be readily detectable through image analysis procedures performed on LANDSAT multiband imagery.

A preliminary test of this hypothesis was performed in October 1976. Ground truth recorded in the form of summer 1976 maps of five dense musk thistle infestations ranging from 8 to 70 acres in extent in Marshall and Nemaha counties, Kansas was acquired from Byron Patton, Weed and Pesticide Division, Kansas Department of Agriculture. The satellite imagery used in the test were LANDSAT black and white transparencies at a scale of 1:1,000,000 of bands 4, 5 and 7 of the 18 June 1976 LANDSAT frame covering the area of interest. Exact locations of the three largest infestations (70, 40 and 20 acres) on the imagery were determined. The three transparencies were then examined separately on a Variscan Rear Projection Viewer at magnifications ranging up to 47X to determine if the infested areas showed distinctive tonal characteristics on any individual band. Results were negative. The three bands were color combined first pairwise and then together on an Itek Color Additive Viewer Printer to determine if this procedure could enhance discrimination of infested areas. Again, no difference between infested areas and surrounding vegetation was discernible.

The results from the LANDSAT imagery while disappointing were not wholly unexpected. Though the imagery was cloud-free, considerable haze was present. This without doubt reduced the probability of success. Further, because of resolution limitations manual interpretations cannot provide the sort of information extraction available through computer processing of LANDSAT tapes.

Based on the success of the 1976 flight during the flowering stage, a second mission was flown on June 9, 1977 to further evaluate the detectability of this stage with aerial photography. The area covered consisted of four flight lines, totaling approximately 100 square miles, in Washington and Nemaha counties, Kansas. The imagery acquired consisted of 1:15,000 scale color infrared photography.

Ground truth for this mission was acquired on June 8, 1977. This effort identified 9 musk thistle infestations of varying size and density. However, in the course of this survey, it became apparent that these infestations were, in general, smaller and/or less dense than those used in the 1976 flowering stage study. The major factor influencing this

unforeseen development was the severe winter of 1976-77 which produced extensive die-back in overwintering rosettes and thus, since flowering is dependent on a rosette reaching a critical size, reduced flowering to a great extent. In total a ground truth data was collected for 23 fields.

Evaluation of the aerial photography in conjunction with the ground truth data showed that even in the case of fairly large dense infestations musk thistle could not be positively identified.

This outcome resulted in the following conclusions.

1) Except for very large dense infestations, scale 1:15,000 (with color infrared film) is too small for reliable detection.
2) If the infestations such as those observed are more the rule than the exception this scale/film combination is not usable for routine monitoring.

In spite of the mixed successes obtained in the remote sensing efforts, the positive detection during the flowering stage was encouraging, especially as it related to a program of integrated pest control. As a result, the KARS program, in cooperation with the Weed and Pesticide Division of the Kansas Department of Agriculture, the State Biological Survey of Kansas and the University of Kansas Division of Biological Sciences, initiated an interdisciplinary study of musk thistle. In September, 1977 funding for the study entitled "Pesticide Use Reduction through Integrated Control Procedures on Musk Thistle (Carduus nutans)" was received from the United States Environmental Protection Agency. The proximate objectives of this research are summarized as follows:

1. To gain a more complete understanding of the biology of musk thistle and its interaction with biotic and abiotic factors.
2. To develop operational procedures for monitoring and detection via remote sensing technology.
3. To propose control strategies on the basis of botanical, entomological and remote sensing data.
4. To develop an understanding of the generality of the data generated through studies of morphological and genetic variation of musk thistle on a regional and national level, and through interstate cooperative studies.

These goals taken together will provide the basis for the achievement of maximal control with minimum pesticide use and energy expenditure, and may provide a body of data and procedures of relevance to a broader range of agricultural weed species.

The remote sensing portion of the study has three major objectives: 1) to accurately estimate the number of acres infested and the average number of flowering plants per acre by county and by cover-type (e.g. crop, pasture, forest, etc.); 2) to monitor changes in the density of musk thistle infestations and concurrently the effectiveness of weed control programs; 3) to project the spread of musk thistle populations into high probability areas by locating the distribution of preferred habitats.

Since the onset of EPA funding, the majority of the work has involved the establishment of a multistage sampling technique which combines the satellite and aerial photographic procedures. Continuation of this work will be directed at testing and refining techniques into an operational, cost-effective set of procedures. A study area in which numerous natural musk thistle populations have been located has been selected and centers on Douglas County and portions of adjacent counties as shown in Figure 4. Detailed ground truth of this area is being gathered by the botanists doing research in that area.

The sampling procedure that has been developed for continuation of the musk thistle remote sensing activity has three main phases.

1. Habitat Classification with Satellite Remote Sensing.

   The purpose of this activity is to use satellite imagery to identify and map preferred musk thistle habitats. Nine broad cover-types have been selected on the basis of known musk thistle occurrences and the possibility of inexpensive detection on LANDSAT imagery over large areas. These categories include:

   Rangeland
   - Cool season grasses
   - Warm season grasses

   Cropland
   - Alfalfa
   - Wheat
   - Other

Forest

Riparian

Upland

Urban

Water

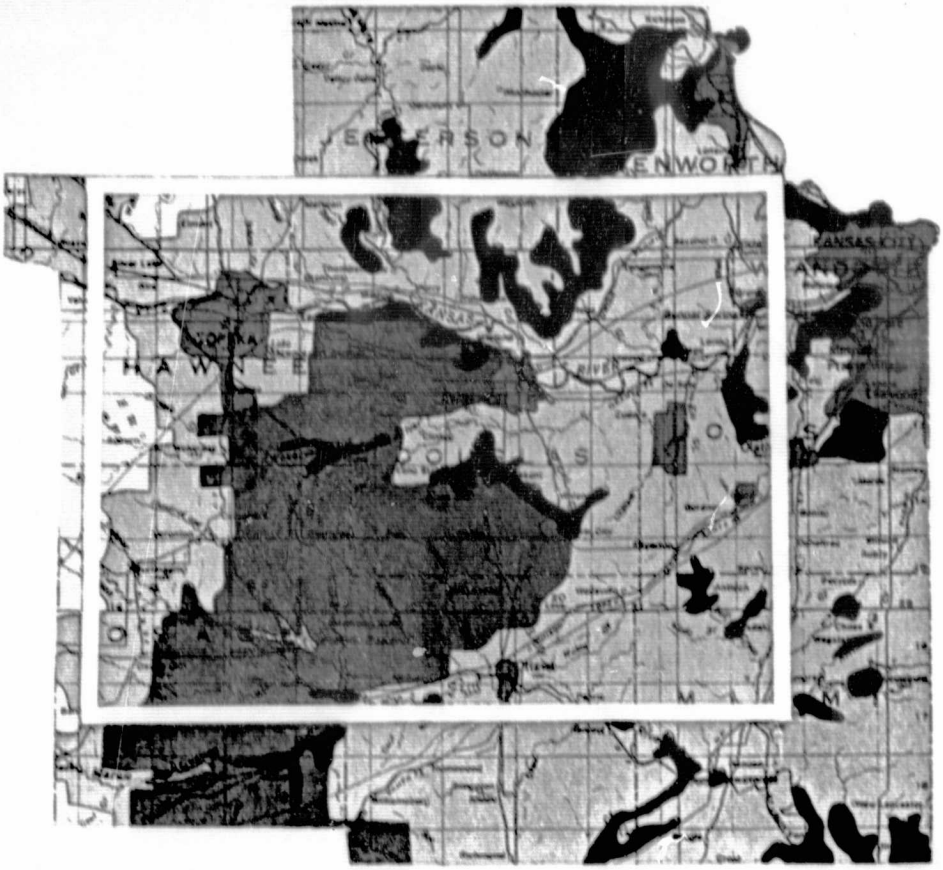
While it is recognized that musk thistle infestations also occur in disrupted areas, as well as in the above categories, those areas along roadsides and in landfills largely occur in association with the above classification.

The results of the first year studies will provide a basis for evaluating the cover-type categories with respect to habitat preference and detectability from LANDSAT. An increase or decrease in the number of categories will be made on the basis of the difficulties experienced in operational use. The habitat preference weighting values which are a component of the multistage procedure will also be upgraded on the basis of the field checking and general habitat survey.

In addition to the above, study of a different regional area has been undertaken to determine the suitability of these categories and the weighting procedures in a different geographic location. Because this portion of the remote sensing studies can provide a basis for projection of musk thistle spread, it is important to correct for regional habitat differences.

2. Aerial Photography in Selected Unit Areas.

Because the cost of acquiring and interpreting large scale aerial photography (sufficient to identify individual musk thistle infestations) over large areas would be prohibitive, a multistage sampling procedure was designed whereby the satellite-derived cover-type information described above could be used to select portions of the study area for detailed aerial photographic study. These "Selected Unit Areas" were chosen, using statistical sampling procedures, on the basis of aggregated "preference values" which were derived from preference weighting scores for each cover-type



UNIRRIGATED CROPLAND- areas with 60 percent or more unirrigated cropland.

UNIRRIGATED CROPLAND WITH RANGELAND- areas with 50 to 60 percent unirrigated cropland and 30 to 50 percent grassland.

RANGELAND- areas with 80 percent or more grassland.

WOODLAND- areas with 70 percent or more woodland, but omitting minor streambank woodlands.

WATER- major reservoirs and permanent semi-natural water bodies.

URBAN & BUILT UP LAND- major areas of intensive use such as towns, industries, and airports.

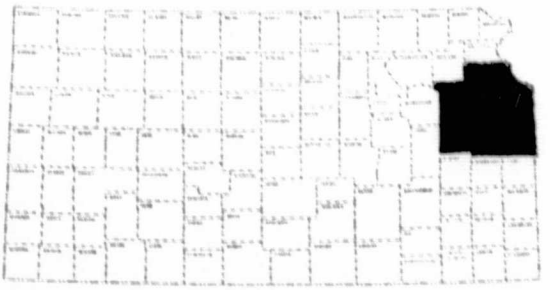


Figure 5. Location of musk thistle study area and related land use categories.

and the area occupied by each cover-type. The numbers of flower heads were counted on the aerial photographs and the results for the Selected Unit Areas used to predict infestation levels over the entire study area.

The results of this effort are now being analyzed to evaluate the type of film and the scales used in acquisition. This evaluation is made on the basis of interpretation results, contrast and accuracy, as well as their suitability for use in the new regional study area described above.

The total sampling procedure and the length of flight segments are also being adjusted in light of cost-effectiveness for an operational program. Since this portion of the remote sensing effort determines the accuracy of the counts and provides the basis for monitoring population changes, the techniques must be accurate and repeatable.

3. Ground Visits.

To verify the interpretation of the photography and establish the ratio of photographic counts with true counts, each population detected with aerial photography was visited. The botanical group also concentrated a portion of their efforts on these populations to provide additional biological data relevant to the remote sensing work. These ground checks will be used to assess the accuracy of the counts by county and by cover-type. Field data generated during this effort will additionally be used for change detection and projection of musk thistle spread.

With the information generated from these three phases the number of acres infested and the number of flowering plants per acre were calculated by county and by cover-type to provide preliminary data for field checking. This field checking will be completed in the coming season.

Sand Hills State Park

On March 11, 1974 Kansas Governor Robert Docking signed House Bill 1723 establishing the 22nd State Park of Kansas. Under the provisions of House Bill 1723, the Kansas Department of Corrections transferred

jurisdiction of Land, township 22 south, range 5 west, section 23, Reno County Kansas, to the Kansas State Park and Resoures and Resources Authority (KPRA). In the spring of 1977 the Dillon family donated an additional 320 acres at the park's immediate western edge. With this donation KPRA completed the acquisition of almost two square miles of land in a scenic sand dune area of southcentral Kansas.

The site is located within the Great Bend Sand Plains area of the Central Great Plains. The focal point of the park is a series of very striking sand dunes, some of which are 40 feet high. It is believed that these surface deposits of sand were formed in late Pleistocene or early recent times as sand was blown up out of the Arkansas River valley by prevailing southwesternly winds. These are very delicate ecological areas, only partially stablized by a thin cover of vegetation. In dune areas where vegetation is damaged or destroyed, wind erosion may rapidly extract its toll and create what is known as a "blowout". The key long-range concern of the park planners was to develop a master plan that would maximize scenic access to these dunes while minimizing physical contact with the ecologically delicate areas.

The area, designated as Sand Hills State Park, is located 3 miles northeast of Hutchinson, one of the largest population centers in the state. Because of its anticipated heavy use, it was the desire of the Park and Resources Authority to begin development of the park facilities during the early summer of 1977. Of immediate concern was the question of how to allocate the efforts of approximately 30 teenagers hired under the federal Youth Conservation Corps Program (YCC) to aid in the park development. This question was a particularly weighty one, since it was important to provide the young people with a meaningful field experience but at the same time ensure that their efforts did not run counter to the conservation goal of the planners. Development of any kind, however, was hampered by a lack of adequate land cover information on which to base a master plan. Further compounding the problem was the fact that KPRA was also considering the purchase of another tract of land that was available immediately to the east of the park area. On May 11, 1977, State Park and Resources Authority Director Lynn Burris requested the assistance of the KARS Program regarding Sand Hills State Park.

After meeting with park planners and researching sources of existing photography, personnel of the KARS program decided, due to the detailed nature of the required information and the rapidity with which it was required, that a special low altitude flight would be necessary. KARS contacted Wilson and Company, Consulting Engineers, in Salina, Kansas and discussed the flight requirements.

Wilson made the flight in early June using black and white panchromatic film in a 6" focal length, 9 x 9 inch format camera. Original negative scale was 1:4,800, stereo coverage, with a total fo 22 photos in 2 flight lines. In addition to the original negatives, KARS received two sets of prints.

Using a radial line plotting technique, one set of photographs was mosaiced together to produce a semi-controlled mosaic of the park area. A sheet of acetate drafting film was laid over the mosaic and prominent linear features such as fence lines, power lines, roads, trails and an adjacent railroad line were traced onto the acetate. Lacking any other maps of similar scale and detail, this acetate tracing became the base map for all subsequent interpretations.

As a result of several discussions with KPRA planners, a set of 14 land use/land cover categories were derived and mapped onto the acetate base. The categories were as follows:

Low Dunes	Grassland
High Dunes	Cropland
Exposed Sand	Power Lines
Ponds	Buried Gas Lines
Marshes	Fences
Stream Beds	Unimproved Roads
Trees	Trails and Weak Tracks

Once the mosaic and the base map were prepared these categories were interpreted and recorded onto the base at the 1:4,800 scale. In a number of instances the second set of photos were used to provide stereoscopic viewing and to improve interpretation capability. A photo reduction of the compiled data was then made at a scale of 1:9,600, the standard planning scale used by KPRA. This reduction was used to prepare a series of 15 negative overlays, one for each of the

categories and one for the base outline of the Park. These negatives, with appropriate annotations, resulted in two different kinds of final graphics. One graphic was a set of film positives, each depicting a different category of land use/land cover. The other graphic was a full color composite map of the area showing all the categories. This was prepared using Kwik-Proof process colors on a white polyester base sheet. In all there were four different kinds of graphics prepared from the aerial photography, each fulfilling a specific need for KPRA.

In order to provide data in a short period of time to the park planners, they were initially given a copy of the 1:4,800 compilation map. This presentation afforded a means of quickly identifying areas for immediate work by the YCC. The rapid turnaround time provided by the remote sensing data on this part of the project was notable. Although the KARS Program received the request for assistance only four weeks prior to the arrival of the YCC workers, the initial land use map was in the hands of the Park planners in time to identify a constructive set of tasks for the YCC personnel. Among those tasks were:

1. Removal of all interior fences and repair of the perimeter fences.
2. Repair of the main pond facility dam and overflow system.
3. Renovation of a barn for use as a group shelter.
4. Construction and signing of a trail system in the north central portion of the park.
5. Construction of a secondary parking lot.

During the summer of 1977 all of these tasks were completed.

The full color Kwik-Proof map provided a permanent and attractive generalized record of the land use/land cover at the time of initial park development. As an overview of the area, it proved to be an indispensable aid to general park planning.

The photo mosaic served not only as photo-interpretation base for the maps but also as a permanent detailed record of the initial park environment. Free of the generalization inherent in a mapped portrayal, the mosaic served as the final authority on questions of detail that the map did not clearly answer.

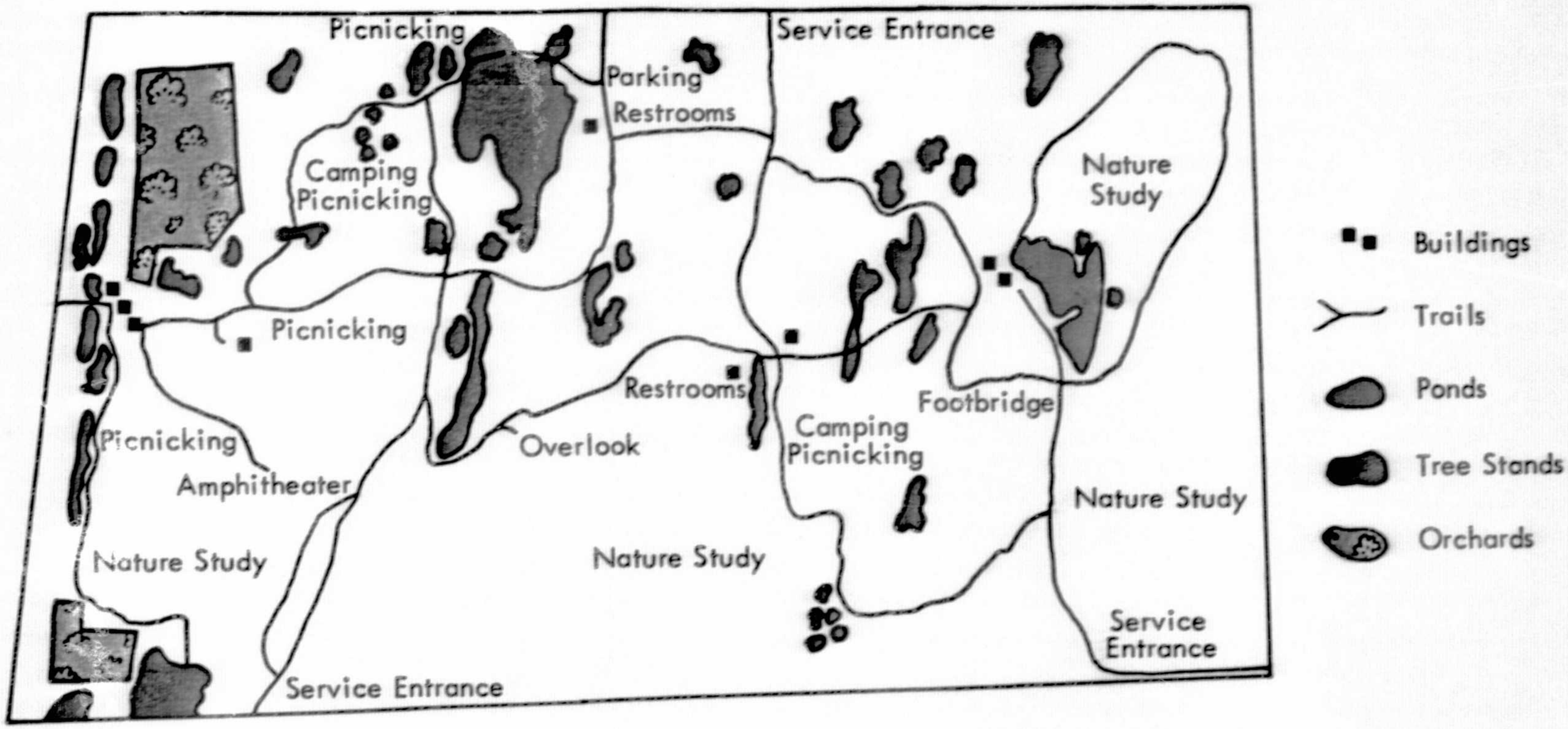


Figure 6. Sand Hills State Park site plan with existing land cover.

The film positive overlays were the major planning tools used in the development of the master plan and were used extensively by the park planners. By compositing selected combinations of KARS overlays with collateral information, areas appropriate to specific kinds of development were distinguished from areas inappropriate to such development. This technique was used to identify potential areas for 6 different categories of development:

1. Roads and parking
2. Camping and picnicking
3. Paths and trails
4. Active recreation
5. Sewage lagoons
6. Recreation buildings

On the basis of the potential areas thus identified, KPRA decided on a general development plan and prepared a master plan map. The plan includes development for six nature study areas, six camping areas, seven picnic areas and several maintenance areas. In addition, service entrances, hiking trails, parking areas and a site for a star gazing amphitheater were chosen.

After the delivery of the KARS map and subsequent preparation of the Master plan, KPRA became impressed with the uniqueness of the Sand Hills area as shown by the maps. The other tract of land to the east, as demonstrated on the land use/land cover map, was far less interesting and unique than what KPRA already had and, it was felt by KPRA, would add little to the park area already held. As a result, $350,000 that had been earmarked for acquiring the adjacent tract was reallocated to other uses. In addition, KPRA also recommended that $100,000 be allocated from Kansas funds for the construction of an interpretive center containing displays and information about the ecology and uniqueness of the Sand Hills. The Governor of Kansas accepted this recommendation and included it in his budget message to the Kansas Legislature in January, 1978.

Total Irrigation Mapping

The Kansas corporate farming laws are currently under review by a Legislative Interim Committee, which is studying the effects of corporate farming activities on the smaller, private farmers. One of the factors of interest is the problem of groundwater depletion due to crop irrigation. Over large areas of southwestern Kansas the saturated aquifer thickness has been reduced by more than 30% over the past thirty years, and is currently being depleted at an accelerated rate due to the rapid increase in the use of irrigation in the area. It is suspected that corporate farming concerns are more likely to be able to make the initial financial outlay involved in installing irrigation systems and may therefore, account for a large proporation of the irrigation. Since the resulting groundwater depletion adversely affects all farmers, the question arises as to whether the private farmer is suffering through the practices of the corporate concerns.

The Kansas Applied Remote Sensing Program is working with the Kansas Legislative Research Department to provide maps and tabular data on total irrigation (center-pivot plus flood irrigation) for the 1976 growing season in six western Kansas counties (Finney, Gray, Haskell, Seward, Sherman and Stanton) totalling 3.3 million acres. This information will be used by the Legislative Research Department to provide the Legislative Interim Committee with information on corporate and private irrigation practices.

Previous work by KARS on irrigation mapping involved identification of center-pivot systems on LANDSAT imagery by their characteristic circular shape. However, floor-irrigated fields do not have such a characteristic shape and an alternative discriminator must be used. It was known that irrigated fields in western Kansas generally have a more vigorous crop cover than similar unirrigated fields. This difference in crop vigor should be reflected in the tonal characteristics of the two types of field, especially in the red spectral band which is sensitive to the low red reflectance of healthy vegetation.

Therefore, an experiment was performed to assess the usefulness of LANDSAT band 5 (red spectral band) imagery for detecting irrigated versus

non-irrigated cropland. Finney County was used as the test area. From consideration of the crop calendars of the major crops in the area, a period between April and September was chosen for study. Band 5 (1:500,000 scale) prints were acquired for all acceptable passes (10% or less cloud cover; quality rating 8) for the April to September 1976 period. Ground truth information comprised of legal description, crop type and irrigated status, was obtained from the Agricultural Extension Agent. A visual measurement of tone was made on each of the fields on each date. Analysis of the results indicated that using just two dates of imagery, May and mid-August, was sufficient to enable discrimination between irrigated and unirrigated fields, using the criteria that the vigorous irrigated crops appear black on the imagery whereas the unirrigated crops appear in grey tones. This result corresponds well with the crop calendars, since during May the wheat fields are green and May imagery is, therefore, needed to identify irrigated wheat. In August the wheat has been harvested and the corn and sorghum (which are not emergent in May) have a dense ground cover; hence August imagery is needed to identify irrigated corn and sorghum. Difficulty was encountered with alfalfa since unirrigated alfalfa has a very dark tone similar to irrigated alfalfa. Also, alfalfa does not have a well-defined crop calendar because it is cut periodically during the season. Due to the problems associated with alfalfa, the likely error entailed in the misclassification of alfalfa was assessed for each county, based on published statistic of county crop acreages, and this figure incorporated into the results of the study.

Using the criterion that an irrigated field will appear black on either the May or the August image, maps were produced for each county showing irrigated cropland. The information was compiled on mylar overlays keyed to 1:250,000 scale county highway maps. To facilitate the location of individual fields on the base map, the center-pivots were first drawn in to provide a reference framework. Individual field boundaries were then drawn in to provide a reference framework. Individual field boundaries were then drawn in and each field colored according to its grey tone. The process was repeated for the August image and the two overlays combined to produce a map of irrigated cropland.

Ground truth data was obtained for samples of all important crop types in each county (mainly wheat, corn, sorghum, soybeans, alfalfa and sugar beets). The data was supplied primarily by the Scott county extension agents and totalled approximately eighty fields per county. These data were used to check the accuracy of the interpretation technique. The interpretation results were generally found to correspond well with the ground truth data. A more quantitative measure of accuracy will be obtained when completed irrigation maps are sent to the extension agents for verification.

To date, compilation irrigation maps have been produced for all six counties. The Legislative Research Department has requested that the irrigation information be provided both in map and in tabular format. The tabular format is required since corporate land-holdings are listed by legal description and are not in map form. About 1900 to 2200 separate legal descriptions are required for each county depending on its size and density of irrigation. Because of the large data volume involved, the tabular data, comprising legal description and type of irrigation for all irrigated fields on a quarter-section basis, has been put onto a computer file. The data can be output simply as a listing of the location and description of irrigated fields or can be sorted to provide various subsets of information or summary statistics.

The Legislative Research Department is using the tabular data to check its corporate ownership records and is annotating the data to identify which of the irrigated areas are corporately-owned. The annotated data will then be returned to KARS and maps prepared showing corporate ownership of irrigated lands. Here again it is anticipated that the computerized data will prove very useful by allowing preparation of the maps directly on a plotter from the computerized data, rather than employing a more time-consuming and costly manual mapping approach. These maps and accompanying tabular data will be included as a major part of the Legislative Research Department's report to the Interim Committee.

The irrigation information provided by KARS will be used by the Legislative Interim Committee in their evaluation of the effect of the

current Kansas corporate farming laws on the corporate and private farming concerns. If a decision is made to change the laws, the irrigation information will have provided an important input into the formulation of the new laws. If the decision is made to not change the laws, the irrigation data will have been instrumental in demonstrating that the situation is not of the magnitude that was initially postulated.

A demonstrated capability and facility with machine-based data manipulation and graphics is an important basis for KARS future work. This project, therefore, serves to provide experience and to demonstrate our capabilities in these areas. Also, the manual field mapping technique developed in this project is a valuable tool in producing satellite-derived maps of cropland areas that are immediately familiar and usable to the potential user. It also holds great potential for combining human capabilities (mapping individual fields onto base maps) and machine capabilities (field-by-field tonal measurement using a spot densitometer to produce spectral and temporal signatures, with subsequent discriminant analysis and crop identification on a field-by-field basis) in analysing and mapping agricultural scenes from LANDSAT data and as a means of providing accurate field maps of irrigation and crop type.

Tauy Creek

Under Public Law 566, the Watershed Protection and Flood Prevention Act, federal funds are provided to watersheds with a history of flooding and related soil and water conservation problems. The process involved in securing these funds is a long one and the watershed district must show a substantial effort in the alleviation of these problems before federal funds will be approved for the construction of large flood control dams within the watershed. The watershed district, much like a city, must receive an article of incorporation from the State. To become an incorporated entity, organizers of the watershed district must show that 50% of the landowners within the district are in support of its formation.

The articles of incorporation then enable the district to levy a tax against the district's landowners to support initial flood control construction and to pay administrative costs.

After receiving the article of incorporation, the watershed district must compile a General Plan for the watershed to show the location of planned flood control structures, the area of protected land, projected costs of construction and land acquisition, and projected savings to landowners as a result of the construction of these flood control measures. This General Plan is then submitted to the State Conservation Commission for comments and approval. Upon approval, the watershed district is then free to begin construction of smaller flood prevention projects and is placed on a priority list for review by state and federal officials for P.L. 566 funding of larger flood prevention dams.

Before any construction can begin, an analysis must be made of the drainage areas above each of the flood prevention structures. To insure that these dams will provide flood protection for an extended period, 75% of the land above the dams must be shown to have stabilized soil conditions or that the use of soil conservation measures on lands used for crop production, pasture or where natural vegetative cover is insufficient to provide stable soil conditions. These measures include the terracing of crop and pasture land and the use of grass waterways to channel runoff.

The Tauy Creek Watershed District No. 82 located in Franklin and Douglas Counties in Kansas requested KARS assistance in implementing the initial construction outlined in their general plan. The initial organizational meetings for the formation of the district were begun in 1960 and articles of incorporation were granted in 1969. The General Plan for the district was finally approved in 1977 and the District's Board of Directors began to consider initial construction projects using funds generated by District tax levies. The Tauy Creek Watershed District's General Plan shows a total of 32 separate flood prevention dams which are arranged at graduated levels to provide flood protection on a progressive basis. Twenty-two of the structures are located in the upper reaches and average 318 acres in size. This represents upstream

protection, not actual surface acreage of the pond. The smallest of the structures covers an area of 96 acres with the largest structure covering an area of 685 acres. The second tier of 8 dams covers a much larger area averaging 1,090 acres. The smallest of these structures covers 595 acres with the largest covering an area of 1,536 acres.

The two final structures of the dams were proposed for P.L. 566 funding and cover areas of 1,952 acres and 3,174 acres respectively. While the district is now awaiting the review process for the P.L. 566 funding, it has decided to go ahead with the construction of the smaller structures using tax generated funds to finance construction. Of the 22 smaller structures, 12 of these structures feature engineering hazards and must undergo a special analysis prior to the construction of the dams. That left ten dams available for immediate construction. The Tauy Creek Watershed Board of Directors requested KARS assistance in compiling an analysis of land treatment and conservation measures in the drainage areas above the proposed damsites. Using existing aerial photography from 1976 and standard aerial photographic interpretation techniques, the degree of land treatment was mapped in each of the ten areas and an assessment was made of vegetation cover for those areas which had not been treated with soil conservation measures. Maps were compiled for each of the areas and using a Hewlett-Packard area digitizer, the amount of acreage was recorded for each of the conservation treatment categories as follows:

Unimproved Cropland - cropland not treated with soil conservation measures.

Improved Cropland - cropland which had been treated using grass waterway and/or terraces.

Unimproved Grassland - Native Natural grasses with insufficient cover to provide stable soil conditions as a result of overgrazing or unstable natural conditions.

Improved Grassland - Grassland treated with terracing and/or grass waterways or with sufficient cover in either a natural setting to provide stable soil conditions.

Forest

Farmyards/Residential

Water - Existing ponds or streams.

Statistics for these categories were then compiled to show the degree of protected land above each of the damsites. It was determined that two of the sites had less than the required 75% of the land in a suitable stable soil condition. These two sites were then eliminated from immediate funding and landowners were contacted to determine when and if land treatment measures were being planned. Two additional sites displayed large farm ponds already in existence near the proposed damsites. These were not considered for immediate funding since additional study was needed to determine the effects that these ponds would have upon the damsites and landowner attitudes towards having additional land taken out of production. A fifth site was also removed from consideration because of the existence of an area of tree and shrub vegetation at the site of the proposed dam. Again, the area was set aside until negotiations could be undertaken with the landowner for tree and shrub removal at the site.

The five remaining sites were all judged to be suitable for immediate construction. The District's Board of Directors then assigned construction priorities for each site based upon the percentage of land on the site that had been suitable treated. The area with the greatest percentage of land in suitable land treatment was given first priority with the remaining areas ranked according to percentage of land treatment and locational considerations. The anticipated cost of this dam is $16,725.

TABLE 4

LAND COVER IN PROPOSED TAUY CREEK DAMSITES

Site #	Construction Priority	Land Cover (Acres)								Percent Stabilized Land
		Farmsteads	Grass	Cropland	Treated Grass and Cropland	Water	Woodland	Hay	Mixed Grass and Shrubs	
7-12	1	-	41	-	118	-	11	-	-	93%
6-8	2	7	43	45	53	2	-	-	84	77%
7-1	3	2	42	33	78	-	17	-	-	79%
3-34	4	4	108	12	118	4	35	-	-	92%
7-30	5	2	25	26	51	-	-	59	-	84%

APPENDIX I:

KARS Newsletter(s)

Kansas Applied Remote Sensing KARS Newsletter

The University of Kansas Lawrence, Kansas April 1977 Volume 6, Number 2

MAPPING RANGELAND VEGETATION CHANGE IN BARBER COUNTY, 1950-1973

The KARS program has prepared two maps portraying the distribution of eastern redcedar (Juniperus virginiana), sand sagebrush (Artemesia filifolia) and other rangeland in Barber County, Kansas in each of two years, 1950 and 1973. The maps, compiled from aerial photography, space imagery and field investigation, consist of transparent color overlays registered to 1:126,720 scale stable copies of the KDOT Barber County highway map.

Sand sagebrush and, more recently, eastern redcedar have been the focus of control efforts in Barber County where they appear to have infested considerable areas of rangeland. Since they are unpallatable to cattle, their economic impact may be considerable. Preliminary analysis of the maps indicates a substantial decrease in the area of sand sagebrush between 1950 and 1973; however, during the same period a rather dramatic increase in redcedar distribution appears to have occurred.

The maps are being utilized by the Sunflower Resource Conservation and Development Project and the U. S. Soil Conservation Service to aid in evaluating the success of control efforts and the need for additional work. Agencies such as the Weed and Pesticide Division, Kansas Department of Agriculture and the Kansas Forestry, Fish and Game Commission will also be making use of the maps to assess problems related to, respectively, redcedar control and wildlife habitat.

R. V. Shaklee, C. T. Traylor

NEW PROJECTS

Selection of Solid Waste Disposal Sites in Riley County

The KARS Program has recently initiated a project with the Riley County Public Works Department to aid in the process of selecting a new county landfill. The Riley County engineer and KARS personnel will first identify areas suitable in terms of physical characteristics such as soil, slope and susceptibility to flooding. Once these areas have been identified, recent aerial photography will be used to prepare detailed land use maps of the proposed sites. These data will then be presented to the county commissioners and to the Kansas State Department of Health and Environment for review. Final site selection will be made by Riley County authorities from the areas approved by the Department of Health and Environment.

J. Poracsky

Evaluation of the Effects of Water Level Manipulation on Waterfowl and Fisheries Habitat Improvement Programs at Council Grove Reservoir

Multidate LANDSAT imagery is being used to assess the extent of shore area exposed during annual reservoir drawdown. Color composites will serve as a basis for evaluating the type and condition of natural and seeded vegetation growth on exposed areas. This data will aid Kansas Forestry, Fish, and Game Commission biologists in determining the success of their water level manipulation program and associated management activities with respect to waterfowl and fisheries habitat enhancement.

J. W. Merchant

RECENT KARS MAPS AND PUBLICATIONS

GUIDE TO AERIAL PHOTOGRAPHY AND SPACE IMAGERY OF KANSAS, December 1976, 62 pp. This publication provides a brief introduction to remote sensing, a section of maps and tables outlining available air photo and space image coverage of the state, and a listing of sources of remote sensing imagery and information. $2.00.

SOUTHWEST KANSAS: INCREASE IN CENTER-PIVOT IRRIGATION FIELDS, 1972-75. Map at scale of ca. 1:1,400,000, 51x66 cm, 2 colors. Covers 32 counties of southwest Kansas on four inset

maps. Shows total distribution of pivot irrigated fields in 1972 and the number of new fields added in 1973, 1974 and 1975. The data were derived from LANDSAT imagery and conventional aerial photography. $3.00.

CENTER-PIVOT IRRIGATED FIELDS, SOUTHWEST KANSAS, 1975. Map at scale of ca. 1:725,000, 51x66 cm, 2 colors. Covers same area as above map but shows total distribution of pivot irrigated fields in 1975. $3.00 each or $5.00 for the pair of maps.

Costs cover printing, postage and handling. Checks should be made payable to the K.U. Center for Research, Inc. (KARS). Forward orders to J. Metcalf c/o KARS Program.

UPCOMING MEETINGS

21-23 June 1977 FOURTH PURDUE SYMPOSIUM ON MACHINE PROCESSING OF REMOTELY SENSED DATA, Laboratory for Applications of Remote Sensing, Purdue University, West Lafayette, Indiana. For information contact: Dr. J.C. Lindenlaub, LARS, Purdue University, 1220 Potter Dr., West Lafayette, Indiana 47906.

9-12 August 1977 SIXTH BIENNIAL WORKSHOP ON COLOR AERIAL PHOTOGRAPHY IN THE PLANT SCIENCES (Special reference to Agricultural and Natural Resources), Colo. State Univ., Ft. Collins, Colo. Contact: R.S. Driscoll, Rocky Mt. Forest & Range Exp. Station, 240 W. Prospect, Ft. Collins, Colorado 80521.

18-21 October 1977 AMERICAN SOCIETY OF PHOTOGRAMMETRY/AMERICAN CONGRESS OF SURVEYING AND MAPPING FALL CONVENTION, Little Rock, Arkansas. Contact: L.R. Fenton, Arkansas Highway Dept., Box 2261, Lt. Rock, Ark. 72203.

KARS PROGRAM 1977

The University of Kansas Applied Remote Sensing (KARS) program is funded by the National Aeronautics and Space Administration (NASA) Office of University Affairs to assist decision makers in local, state and regional agencies in the application of remote sensing techniques to their problems and activities. Persons working in Kansas who believe that they may be able to use remote sensing in a decision-making capacity are invited to contact the KARS Program at the University of Kansas in c/o:

Space Technology Center
University of Kansas
Lawrence, Kansas 66045

913/864-4775 or KANS-A-N 564-4775

The Kansas Applied Remote Sensing Newsletter is published in January, April, July and October by the University of Kansas Applied Remote Sensing (KARS) Program having facilities located in the Space Technology Center, Nichols Hall, The University of Kansas. Publication of the KARS Newsletter is supported by NASA Office of University Affairs Grant No. 17-004-024. Contributions of research findings, announcements of meetings, publications, and information pertinent to remote sensing applications in Kansas or the Midwest/Great Plains region are encouraged. Inquiries and contributions should be addressed to J. W. Merchant, Editor, KARS Newsletter. All correspondence related to specific projects should be addressed to the person indicated.

The University of Kansas Center for Research Inc.
KARS Newsletter
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

PLEASE POST

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KARS Newsletter
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

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Kansas Applied Remote Sensing Newsletter

The University of Kansas Lawrence, Kansas July 1977 Volume 6, Number 3

PLANNING FOR SAND HILLS STATE PARK

Data provided by the KARS Program are being used by the Kansas State Parks and Resources Authority in planning the development of the new Sand Hills State Park. The park is located in Reno County approximately four miles northeast of Hutchinson, Kansas. Large scale (1:4,800) black and white panchromatic aerial photography of the park site was flown during May 1977. During the same period, supportive field work was conducted by KARS personnel.

The aerial photography has been interpreted to provide data on vegetation, land use, utility right-of-ways, trails, drainage, sand dune characteristics, and other features of the park area. Maps of the information and an aerial photo mosaic of the park are now being prepared. Preliminary data are already being utilized by the State Parks and Resources Authority to direct efforts of the Youth Conservation Corps which, during the Summer of 1977, is carrying out trail construction, erosion control and other activities in the park.

J. Poracsky

CENTER PIVOT IRRIGATION MAP USED IN BEEHIVE LOCATION

A map of center pivot irrigation in southwest Kansas (KARS Newsletter, October 1976) prepared by the KARS Program from LANDSAT data, is being used by the Kansas Department of Agriculture to aid beekeepers in determining the best locations for their beehives. According to Mr. Gary Ross, Staff Apiarist, Division of Entomology, in recent years several factors have provoked an upsurge of interest in southwest Kansas among out of state beekeepers. Drought conditions in other areas of the midwest have reduced the availability of forage for bees in many locales. Furthermore, an expanding alfalfa seed production industry in southwest Kansas requires insect pollination. Demand for bees is providing a monetary incentive for beekeepers who provide this service.

Beehive locations are most often selected by means of windshield surveys. However, in southwest Kansas hive site selection is complicated by the large number of center pivot irrigation systems. Over 90% of

CHANGES IN THE GUIDE TO AERIAL PHOTOGRAPHY AND SPACE IMAGERY OF KANSAS

The following changes and additions to the Guide to Aerial Photography and Space Imagery of Kansas should be noted:

p. 4 paragraph 3	Multispectral scanner (MSS) data obtained from aircraft are not available . . . .
p. 15, 16, 41	as of May 1, 1977, ASCS address is: 2222 West 2300 South, P.O. Box 30010, Salt Lake City, Utah 84125 (same phone).

p. 43 add following to ASCS photo coverage:

County	Symbol & Code	Year	(# of Photo-indexes)
Wilson	AZH 20205	54(1)	59(1)
Woodson	AXS 20207	54(1)	59(1)
Wyandotte	ZJ 20209	54(1)	59(1)

County	Year of Photography	
Wilson	66(4)	73(4)WA
Woodson	66(4)	74(4)WA
Wyandotte	66(1)P	

Copies of the Guide may be purchased for $2.00 each from J. Metcalf, KARS Program, University of Kansas Space Technology Center, Lawrence, Kansas, 66045. Checks should be made payable to the K.U. Center for Research, Inc. (KARS).

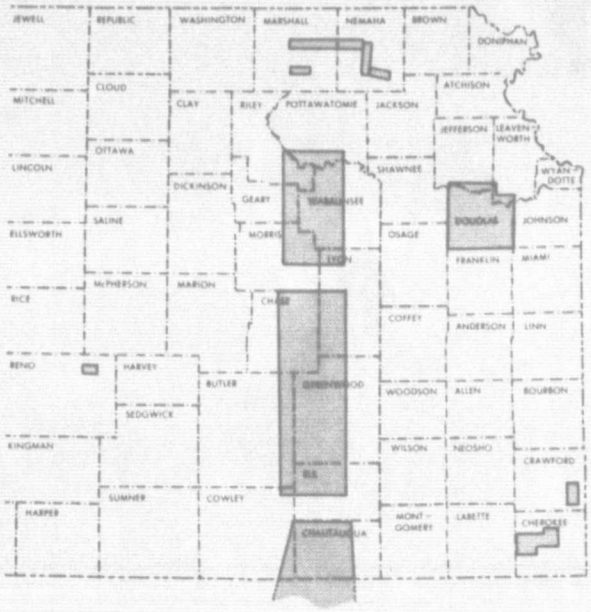
these systems are planted in corn, which provides no forage for honeybees, and are sprayed, at regular intervals, with pesticides toxic to bees. Location of a hive too near a center pivot system enhances the possibility of bee kills which reduce both honey production and pollination. Furthermore, such bee kills impose a burden on the general public since the beekeeper involved may be compensated for his loss under the federally funded beekeeper indemnity act.

The map of center pivot irrigation prepared by the KARS Program has enabled Mr. Ross to assist beekeepers in locating their hives in areas away from center pivot systems. This assistance, which began during summer 1976 has helped reduce bee kills and their associated financial losses in southwest Kansas.

M. Ginevan

RECENTLY ACQUIRED AERIAL PHOTOGRAPHY

The map below indicates aerial photographic coverage obtained for KARS projects undertaken since May 1976. This photography and other imagery, is retained on file in the KARS Laboratory at the University of Kansas Space Technology Center.



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Lawrence, Kansas 66045

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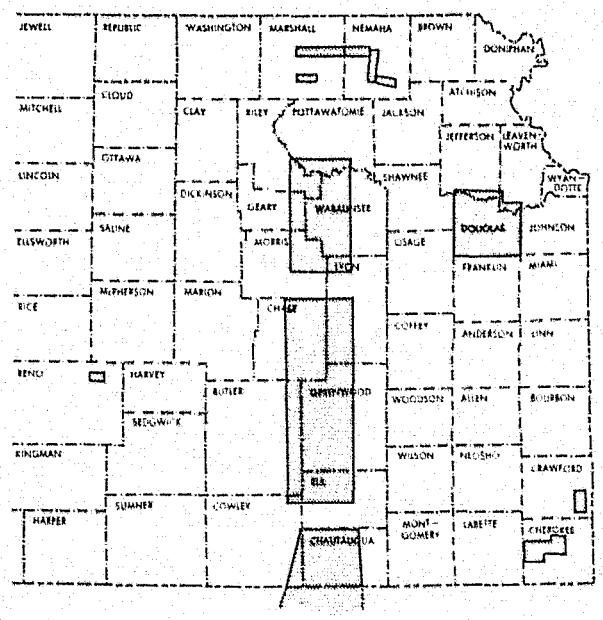
these systems are planted in corn, which provides no forage for honeybees, and are sprayed, at regular intervals, with pesticides toxic to bees. Location of a hive too near a center pivot system enhances the possibility of bee kills which reduce both honey production and pollination. Furthermore, such bee kills impose a burden on the general public since the beekeeper involved may be compensated for his loss under the federally funded beekeeper indemnity act.

The map of center pivot irrigation prepared by the KARS Program has enabled Mr. Ross to assist beekeepers in locating their hives in areas away from center pivot systems. This assistance, which began during summer 1976 has helped reduce bee kills and their associated financial losses in southwest Kansas.

M. Ginevan



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Kansas Applied Remote Sensing Newsletter

KARS

The University of Kansas Lawrence, Kansas October 1977 Volume 6, Number 4

EPA FUNDS MUSK THISTLE RESEARCH

The U.S. Environmental Protection Agency (EPA) has funded the University of Kansas for approximately $70,000 for the first year of a three year multifaceted study of musk thistle (Carduus nutans). Dr. Edward A. Martinko, KARS Project Coordinator, is principal investigator for the research. Investigators from the State Biological Survey of Kansas and the KU Division of Biological Sciences, as well as the KARS program, will be involved in the study.

According to the Kansas Department of Agriculture, more than $20,000,000 is spent annually to control musk thistle in Kansas. The EPA funded research will focus on improving knowledge of the population biology, geographical variation, and distribution of the plant in order to determine the optimal control procedures. Remote sensing techniques will be examined as a means to map musk thistle distributions and monitor control procedures. Aerial photography acquired by the KARS program during 1976 and 1977 has provided evidence that heavy musk thistle infestations can be delineated (KARS Newsletter, July, 1976). Initial remote sensing research conducted under the EPA funding will be aimed at measuring the spectral characteristics of the flower and plant and its environment in order to better define film/filter/scale combinations optimal for detection.

E. A. Martinko

KANSANS PARTICIPATE IN NATIONAL CONFERENCE OF STATE LEGISLATURES LANDSAT WORKSHOP

On September 23-24, 1977, in Snowmass, Colorado the National Conference of State Legislatures (NCSL) conducted a workshop on State Uses of Satellite Remote Sensing for state legislators and agencies representing ten Rocky Mountain and Great Plains states. The workshop was one of five being held across the nation to acquaint legislators with data collection capabilities of LANDSAT and LANDSAT applications to state problems in the region and throughout the U.S.

Dr. Edward Martinko, KARS Project Coordinator, represented the KARS program and participated in a panel discussion on current operational remote sensing applications. Dr. Martinko was joined on the panel by Mr. Bill Hanzlick, representing the Kansas Forestry, Fish and Game Commission (FF&G). Mr. Hanzlick, who has worked closely with the KARS program on numerous projects for over four years, discussed the present and potential utilization of remote sensing by FF&G.

Kansas legislators attending the Conference included Senator Fred A. Kerr (Coats, Kansas) and Rep. Charles J. Schwartz (Junction City, Kansas). Meeting participants took part in discussions of remote sensing applications in agriculture, "208" water quality planning, drought relief, and land use planning, and learned of the availability of NASA assistance in establishing operational LANDSAT utilization programs in the states.

KARS TO ASSIST IN STATE EMERGENCY RESPONSE MEASURES

The KARS Program has initiated a program in cooperation with the Emergency Preparedness Planning Department (EPP) of the Kansas Adjutant General's Office to provide damage assessment and aid in emergency response planning for disaster relief. EPP may call upon KARS assistance in the event of a flood, tornado, severe ice storm or similar catastrophe. Aerial photography of disaster affected areas will be provided by the Kansas Department of Transportation and the Civil Air Patrol. KARS photo interpreters will map the extent of the disaster and assess damage to private (e.g., dwellings, business,

agriculture) and public properties, (e.g., levees, utilities, transportation). The information will assist EPP in allocating relief to affected areas (e.g., food distribution, medical care, deployment of heavy equipment for debris removal, location of law enforcement command posts).

R.V. Shaklee

NASA REGIONAL APPLICATIONS PROGRAM TO AID IN STATE USE OF LANDSAT

On September 1, 1977, the KARS Program sponsored a meeting at the University of Kansas Space Technology Center during which Mr. Lee Tilton, III, Assistant Director of the NASA Regional Applications Program (Slidell, Louisiana) briefed representatives of ten public agencies working in Kansas on LANDSAT applications to state problems. The capabilities of the NASA Regional Applications Program to provide training and technical assistance, and conduct pilot projects aimed at establishing operational LANDSAT utilization programs at the state level were also presented. Mr. Tilton reviewed projects conducted in the states of Mississippi, Texas, Florida, and Louisiana involving wildlife habitat assessment, land use mapping, evaluation of soil erosion potential, and water resources monitoring. All projects were carried out in cooperation with state agencies.

The meeting was attended by representatives of the Kansas Geological Survey, State Planning and Research, Kansas Fish and Game Commission, Kansas Water Resources Board, Kansas Department of Agriculture, State Extension Forestry, State Conservation Commission, U.S. Soil Conservation Service, U.S. Bureau of Reclamation, the Kansas City District —Corps of Engineers, and the KARS Program. The KARS program will shortly be sending a representative to Slidell in order to facilitate NASA assistance to Kansas.

MAPS PORTRAY RANGELAND — CROPLAND CONVERSION IN WESTERN KANSAS

The KARS Program has completed a set of three maps displaying the conversion of rangeland to cropland in three areas of western Kansas (1972-1976). The maps were originally prepared for the Kansas Forestry, Fish and Game Commission in support of their analysis of potential pronghorn antelope release sites. Rangeland changed to cropland in each year since 1972 is portrayed in a different color on the maps. The three maps cover, respectively (1) the Ellsworth, Saline, Lincoln county area, (2) the Clark, Meade county area, and (3) the Gove, Trego, Ellis, Lane, Ness county area. Details on map availability are available upon request.

T. Talmon

KARS PROGRAM 1977

The KARS program has been established by NASA to assist public agencies working in Kansas in using remote sensing techniques. Persons wishing further information are invited to contact Dr. Ed Martinko (913/864-4775).

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Kansas Applied Remote Sensing Newsletter

The University of Kansas Lawrence, Kansas January 1978 Volume 7, Number 1

WYOMING ANTELOPE FIND NEW HOMES IN KANSAS

The State of Kansas is richer by a hundred antelope this year after the Kansas Fish and Game Commission (KF&G) introduced them to two new areas in the state. The two releases were the culmination of a six month planning effort by KF&G and KARS personnel (KARS NEWSLETTER, Vol. 5, No. 4).

At the request of KF&G, the KARS program staff evaluated three potential release sites to determine the extent of agricultural encroachment onto rangeland. LANDSAT imagery was used by KARS personnel to map changes in land-use for a five year period from 1972-1976. This information was then used by KF&G biologists to determine those sites in which the antelope will have the greatest chance of becoming established.

In early January of this year, KF&G personnel traveled to Wyoming, trapped the 100 antelope, and returned with them to Kansas. One group of 63 antelope was released at a site in south central Kansas (Clark County), while the other 37 were released in the Flint Hills (Chase County). Combined with previously established herds in western (Wallace and Logan Counties) and south central Kansas (Barber County), these two releases bring the population of pronghorn antelope in the state up to about 1200 distributed in four different locales.

(Ted Talmon)

KANSAS ACADEMY OF SCIENCE MEETING

On Friday and Saturday, April 14 and 15, the Kansas Academy of Science, the oldest Academy of Science west of the Mississippi, will be holding its 110th Annual Meeting in the University of Kansas Union Building on the Lawrence campus. General paper sessions will be held both mornings on a variety of subjects. The largest number of papers deal with Biology and Agriculture but also included are "Earth and Environmental" sessions, a "Special Session on Land Use" and sessions concerning at least ten other subject areas.

Friday afternoon features two special symposia. One deals with methods for teaching about the environment and environmental problems. The other concerns "Remote Sensing in Environmental Analysis and Planning in Kansas" and was organized by the KARS Program. Several Universities and state agencies will be represented in the Remote Sensing Symposium (see program inside this newsletter) and it is hoped that the interchange of ideas that occurs during the symposium will serve to further expand understanding about remote sensing within both the academic community and state agencies.

The Academy's Annual Meeting is open to everyone and non-members are welcome to attend. For further information contact:

Eugene C. Bovee
Division of Biological Sciences
University of Kansas
Lawrence, Kansas 66045

SAND HILLS STATE PARK MASTER PLAN COMPLETED

During the late spring and early summer of 1977, KARS personnel used aerial photos to map land use/land cover in the newly acquired Sand Hills State Park site (Reno County) for the Kansas Park and Resources Authority (KPRA.) The land use/land cover map delineated eleven different categories of features: high dunes, low dunes, bare sand (blowout) areas, grassland, agricultural areas, roads, fences, wooded areas, marshes, water bodies and utilities. This 1:9,600 scale map was intensively used by the park planners in the preparation of the park master plan.

The first and most immediate result of the interpretation was the identification of several short-term development projects within the park area. These were undertaken and completed by a group of Youth Conservation Corps workers during the summer of 1977 (KARS Newsletter, July, 1977.) The second result of the interpretation came about late in the Fall when the Master Plan for the park was completed by KPRA.

The focal point of the park area is a series of very striking sand dunes, some of which are 40 feet high. These are very delicate ecological areas, only partially stabilized by a thin cover of vegetation. In dune areas where vegetation is damaged or destroyed, wind erosion may rapidly extract its toll, creating a "blowout." The key long-range concern of the park planners was to develop a master plan that would maximize scenic access to these dunes while minimizing physical contact with the ecologically delicate areas.

By compositing selected combinations of KARS delineated features with collateral information, areas appropriate to specific kinds of development were distinguished from areas inappropriate to such development and a Master Plan was developed. The adopted plan includes development of six nature study areas, six camping areas, seven picnic areas, several maintenance areas, location of service entrances, hiking trails and parking areas. In addition, a large Interpretive Center is designed to describe and interpret the unique character of the Sand Hills Park area.

The master plan estimates park usage at more than 100,000 visitors annually. In the future the master plan, developed through the use of the remote sensing data, will continue to guide the development of this scenic natural area.

(Joe Poracsky)

THE TAUY CREEK WATERSHED

Under Public Law 566, Watershed Protection and Flood Prevention Act, federal funds will be available for the construction of major flood water retardation structures within watersheds provided that the watersheds meet specified federal criteria. The Tauy Creek Watershed Planning District No. 82, located in Southern Douglas County and Northern Franklin County, is in the process of planning and implementing flood prevention and soil conservation measures for the watershed that will enable it to qualify for the federal funds.

One portion of the federal guidelines specifies that floodwater detention structures of a lesser scale than the P.L. 566 structures must be built above the proposed P.L. 566 structures. To comply with this, a total of 22 flood detention structures have been planned in the Tauy Creek District.

Another portion of the criteria specifies that at least 75% of the area above each of these detention structures must be treated with soil conservation practices. To insure conformity with the federal requirements, the Board of Directors of the Tauy Creek Watershed Planning District requested KARS assistance in compiling the necessary land use information for the watershed. Using existing aerial photography, land use in 10 of the 22 flood retardation dam sites was mapped into categories that classified degree of land treatment in the area above the structures. The 12 remaining sites were not mapped at this time due to engineering problems which will require special study before these sites can be considered.

The aerial photography showed that in two of the proposed dam sites an insufficient amount of land had the necessary treatment. These two sites, therefore, were eliminated from consideration for immediate funding. The photography also showed the existence of farm ponds near two additional sites, thus necessitating additional study before funding can be considered. A fifth area was shown to have an extensive area of shrub and tree vegetation lying within the proposed dam site. It too was not considered for initial funding, subject to discussions with the landowners concerning the clearance of the vegetation from the dam area.

From the maps, data on land treatment was compiled for the five remaining sites and presented by KARS to the Tauy Creek Watershed Board of Directors. From this data priorities were assigned to the construction of the five remaining structures. The Board of Directors is now in the process of contacting landowners in the five proposed sites and securing their approval before the final allocation of funds will be made and construction begins.

(Ron Shaklee)

A Symposium on

REMOTE SENSING IN ENVIRONMENTAL ANALYSIS AND PLANNING IN KANSAS

to be held during the 110th Annual Meeting of
The Kansas Academy of Science
at the Kansas Union Building, University of Kansas
Friday, April 14, 1978, 1:30-4:00 p.m.

Remote sensing commonly refers to the collecting of information from some kind of airborne or spacecraft borne sensor. The earliest of these sensors, the aerial camera, has in recent years been joined by other instruments such as the multi-spectral scanner, thermal infrared scanner and radar. Each of these sensors is capable of providing unique kinds of data about the environment.

Since a number of the sensors and techniques available in remote sensing are quite new, many workers in the environmental and planning fields are unfamiliar with them. The Symposium is intended to help overcome this unfamiliarity. The papers to be presented in the first portion of the program will address the questions: what is remote sensing and what are some of the ways that it is currently being used in environmental analysis and planning in Kansas? The panel discussion in the second portion of the program is intended as a forum for exchanging ideas about applications of remote sensing that may exist now or that may emerge in the near future.

* * * * * * * * *

Paper Presentations: CURRENT APPLICATIONS

Remote Sensing: An Overview of the State of the Art and Its Applications in Kansas
T. H. Lee Williams, Department of Geography and KARS Program, University of Kansas

Aerial Photography in Highway Site Analysis
Lewis Myers, Environmental Support Section, Engineering Services Department, Kansas Department of Transportation

Aerial Photography of Archeological Sites in Kansas
Thomas Witty, State Archeologist, Kansas State Historical Society

Thermal Infrared Scanning for Surveying Heat Loss in the City of Wichita
K. Sam Shanmugam, Department of Electrical Engineering, Wichita State University

Panel Discussion: EMERGING NEEDS AND CAPABILITIES

Moderator: B.G. Barr, Director, Space Technology Center, University of Kansas

Janét Bare, Assistant Director, Remote Sensing Laboratory, University of Kansas

Claude Keithley, Department of Regional and Community Planning , Kansas State University

Chris McKenzie, Policy Analyst, Division of State Planning and Research

Rolfe Mandel, Research Associate, Institute for Social and Environmental Studies, University of Kansas

Ed Martinko, Project Coordinator, Kansas Applied Remote Sensing Program, University of Kansas

* * * * * * * * *

For further information, contact: Joseph Poracsky
Space Technology Center
University of Kansas
Lawrence, Kansas 66045
(913) 864-4776 or KANS-A-N 564-4776

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NEW RESEARCH ASSOCIATE JOINS KARS STAFF

Dr. T. H. Lee Williams recently joined the KARS Program staff as a Research Associate. Dr. Williams is a remote sensing specialist with a background in agricultural land use studies. His research has included work in the problems of collecting contemporaneous ground truth information for satellite and aircraft land use studies and work with techniques of image enhancement. Dr. Williams holds a PhD in Geography from the University of Bristol (England) and is currently an Assistant Professor of Geography at the University of Kansas where he offers several courses in remote sensing. Prior to coming to Lawrence in the Fall of 1977 he was a Visiting Research Associate in the Department of Geography at the University of Oklahoma.

KARS REPRESENTED AT REMOTE SENSING SOCIETY CONFERENCE

The range of applied remote sensing projects carried out in the KARS program was the theme of a display presentation given at the Remote Sensing Society Conference held in Sheffield, England, in December. The conference theme was "Third World Applications of Remote Sensing" and resulted in a general discussion of the problems and approaches to transferring remote sensing technology to the user, both in developing and developed countries.

Dr. T. H. Lee Williams of the KARS staff presented a paper at the conference entitled "Low Cost Image Enhancement Using Color TV System," co-authored with Dr. Jim Goodman of the University of Oklahoma. The paper dealt with the use of a color TV system for enhancement of LANDSAT false color composite images in terrain type mapping.

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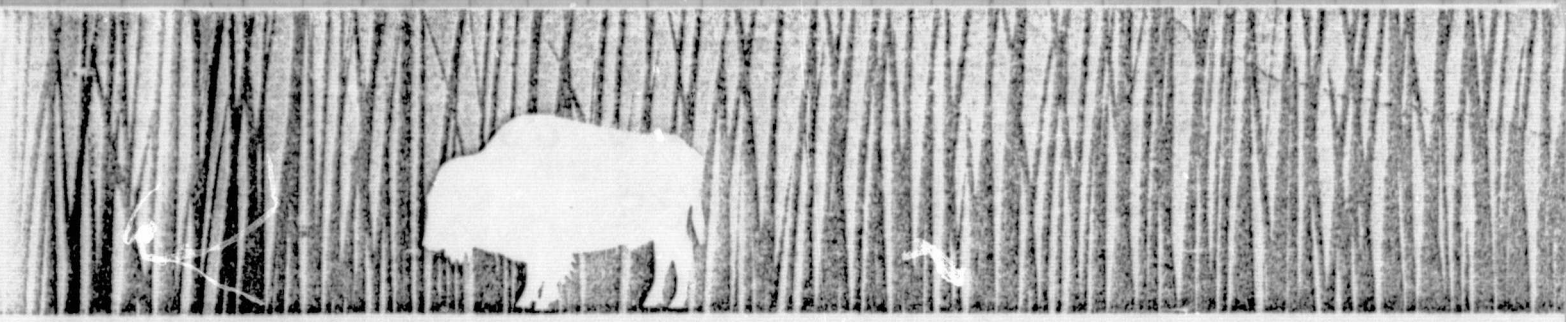
The University of Kansas Center For Research, Inc.
2291 Irving Hill Drive—Campus West
Lawrence, Kansas 66045

APPENDIX II:

Supportive Letters



Save the Tallgrass Prairie, Inc.

4101 West 54th Terrace, Shawnee Mission, Kansas 66205

STP Information Office
(913) 384-3197
Elaine Shea, Director

March 28, 1977

Dr. B.G. Barr
1605 Crescent Road
Lawrence, Kansas 66044

Dear Bill:

Ever since you described the high altitude aerial photography program to us at Charlie Stough's cabin last fall we have been intrigued with the possibilities it could provide for site selection for a Tallgrass Prairie National Park.

While in Washington last week I had a chance to ask Larry Winn about combining or adding this objective to the NASA flights scheduled this spring researching the musk thistle in northern Kansas counties. We were delighted to hear him say that he had already requested this and that you would know when the information would be available.

We look forward to the help this will give us and would be very interested in meeting with you or a member of your staff to help us interpret the data whenever it is available. Probably the easiest way of reaching us is through Charlie's office in Lawrence. His phone number is 843-5333.

We are drafting our bill which Larry has agreed to enter when we are ready. The timing for the idea of a prairie park appears to be much improved and we are quite encouraged by the strong support and enthusiasm we received in Washington. It looks like we have hard but rewarding work ahead.

Give Martha my best and tell her we should have word from the Willoughbys after my Bill returns from Aspen where they will be skiing together. (The original trip was dashed on the rocks, literally, with no snow over New Year's!)

Sincerely,

Elaine

Elaine Shea

City of Lawrence
KANSAS

BUFORD M. WATSON, JR., CITY MANAGER

CITY OFFICES 910 MASSACHUSETTS ST.
BOX 708 66044 913-841-7700

June 17, 1977

Dr. Edward Martinko
The University of Kansas
Space Technology Center
Lawrence, Kansas 66045

Sir:

The City of Lawrence, Kansas Planning Office would like to obtain an aerial photograph of the area containing the Lawrence Memorial Hospital. As you may know, there has been much discussion recently about where doctors should locate their offices both by the Pinckney neighborhood and by the City Commission.

We would like to obtain the aerial photograph to study potential doctor's office sites around the hospital. The photograph will be very useful for determination of existing land use around the hospital study area. Also, the photograph will be used as a visual display tool when the staff presents its report on the potential sites for the location of doctor's offices.

We would appreciate any assistance you might be able to provide us concerning this matter.

Sincerely,

David R. Guntert

David R. Guntert
Planner 1

DRG:tfg

DAN R. HARDEN
Registered Professional Engineer
No. 7412
COUNTY ENGINEER &
DIRECTOR OF PUBLIC WORKS
Office Phone 913/776-4413

RILEY COUNTY
PUBLIC WORKS DEPARTMENT

MANHATTAN, KANSAS 66502

January 12, 1977

Mr. Ted Talmon
2291 Irving Hill Drive
Lawrence, KS. 66045

RE: Riley County Landfill Site Selection

Dear Mr. Talmon:

Please consider this letter my formal request for information from the KARS Program that may be of assistance in selecting a future site for the Riley County Landfill. The present site has about 2 1/2 years of capacity left so a decision on this matter will be made in the near future. It is my understanding that the KARS Program can supply this information at no cost to Riley County.

The Kansas State Department of Health and Environment's Division of Environment is interested in the following information when making an approval of a site.

A. accessibility
B. geology and soil information
C. type and availability of fill material. We must cover everything with 6 inches of cover at the end of each day. We must place 30" of final cover over the entire area after filling is completed.
D. drainage and the probability of flooding on the site.

Riley County will submit 2 to 4 potential sites to the Division of Environment for approval. From the sites approved by the Division the final site will be selected locally. In this regard additional information concerning the land use inventory of the area within a 1000 ft. radius of each potential site, the size of the area and the type and amount of vegatation in the immediate area on and around each site.

These sites will also be studied as possible sites on which to use other disposal technologies that can be used in conjunction with landfilling. Shredding and incineration will be the technologies studied.

RILEY COUNTY PUBLIC WORKS DEPARTMENT

Dan R. Harden, P.E.
Director and County Engineer

DRH:je
Enclosure
Copy: Landfill

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
ANADARKO AREA OFFICE
P. O. BOX 368
ANADARKO, OKLAHOMA 73005

IN REPLY REFER TO:
Land Operations

APR - 4 1978

Mr. Ron Shaklee
University of Kansas
Center for Research
2291 Irving Hill Drive
Campus West
Lawrence, Kansas 66045

Dear Mr. Shaklee:

We understand that your space technology office is planning a research project in the Soldier Creek Watershed, Jackson County, Kansas, which includes lands owned by the Potawatomi Tribe of Kansas.

The Horton Agency, Horton, Kansas, has responsibility for the management and protection of lands within the Potawatomi Reservation. This responsibility includes mapping and surveying trust resources and planning for optimum utilization beneficial to Indian owners. These activities are carried out by programs of the Horton Agency Office.

To the extent that your research will benefit Agency resource programs and Indian land owners, we offer our cooperation and support. Our Agency resource people will no doubt be able to make beneficial use of at least a part of the data that you will gather.

Please contact Agency Superintendent Donald Loudner, Horton Agency, or Jim Stivers, Agency Land Operations Officer, Horton, Kansas, if you wish specific information or assistance with Potawatomi trust lands.

Sincerely yours,

Area Director

STATE OF KANSAS
Forestry, Fish and Game Commission

Route #2 Box 6
Pittsburg, Kansas
66762

January 21, 1978

Ted L. Talmon
Kansas Applied Remote Sensing Program (KARS)
Univ. of Kansas Center for Research, Inc.
2291 Irving Hill Drive - Campus West
Lawrence, Kansas 66045

Dear Ted,

As I have stated many times in past conversations with you, remote sensing has proven to be an invaluable aid for providing management and development recommendations for reclaiming the Mined Land Wildlife Area and other surface-mined tracts of land for recreational utilization in Southeast Kansas.

Field inspections and surveys often times were inadequate in providing the required amount of information necessary to insure the most efficient expenditure and utilization of the limited amount of funds our Agency has to work with each year on this Area for reclamation and development.

Many problems have impeded the formulation and implementation of a comprehensive recreation reclamation plan for fish and wildlife habitat development on the Area. These are: the scattered location of the 26 units throughout a two county area, the heterogeneous nature of each unit comprising the Area in respect to resultant change in topography after the mining, creation of numerous strip-mine lakes and ponds, radical changes in drainage patterns, wide differences in the amount and type of volunteer vegetation establishment, and the existence of highly acid sites that contribute acid-mine drainage to strip-mine lakes and streams. Past efforts have focused on delineating and reclaiming the most obvious acid sites such as abandoned tipple sites where the coal was processed, and concentrating attempts at developing and enhancing wildlife habitat and user access near the larger strip-mine lakes. The delineation of locations where reclamation would be most beneficial was very time consuming and involved many mandays in the field.

The recent use of remote sensing from photographs provided by KARS has been very helpful in providing direction to our Agency in designing a comprehensive plan of development where we no longer have to make impromptu or hasty decisions on how we are going to use funds after or if they are granted. Use of remote sensing has

eliminated much of the time required to delineate sites and other features so as to give a total overview as to the scope of the problem and just exactly what needs to and can be accomplished over increasing intervals of time. Remote sensing has been quite useful in allowing us to map and inventory all the acid sites, bodies of water, sites where vegetation is having difficulty becoming established, drainage patterns, and success of habitat manipulations and past reclamation work. The technique has been used extensively to substantiate the need for further reclamation work on sites where past efforts were not totally successful such as the failure to establish the desired vegetation requiring additional liming and seeding.

Our participation in the Program in relation to the use of remote sensing on surface-mined lands for fish and wildlife development has been very successful and of great benefit to our Agency. Cooperation and assistance from personnel at the Center for Research, Inc. has been terrific and very helpful. Future use of this technique is desired, and the possibility of expanding its uses seem real as our personnel learn more about this technique. Funding for continued use of remote sensing on the Area has been requested for in our budget, and it is hoped we can continue our participation in the Program. Thank you.

Sincerely,

Patrick Bonislawsky

Patrick Bonislawsky
Fisheries Biologist

THE STATE OF KANSAS

THE KANSAS STATE PARK AND RESOURCES AUTHORITY
503 KANSAS AVENUE, P. O. BOX 977
Phone (913) 296-2281
TOPEKA, KANSAS 66601

May 11, 1977

Professor B. G. Barr
Director, Kansas Applied Remote
Sensing Program
Space Technology Center
Lawrence, Kansas 66045

Dear Professor Barr:

Tim Traylor, of your staff, has met with us several times to explain the function of your organization, and he has been very helpful in a number of areas. We are in a position now to officially request that your organization help us with some of our current problems.

This summer the Park and Resources Authority plans to improve the Sand Hills State Park, located two miles northeast of Hutchinson, Kansas. The park is currently unimproved land consisting of about two square miles of mixed rangeland and woodland. Our idea is to hire teenagers under the Youth Job Corps and to use these young people in a combination work and field experience mode. We will be able to provide jobs and at the same time provide an educational experience in outdoor recreation and ecology for these young people.

However, we do need additional information about the park area to help us decide where these young people should be put to work. It would help us if your organization could provide the following, using interpretation from remote sensing:

1. Establish existing vegetation patterns including the various different ecological zones that exist.
2. Identify potential sites for scenic areas, parking areas, sanitary facilities, remote camping areas, picnic areas, and trails.
3. Identify unsightly and hazardous areas throughout the park that need attention or avoidance.

If you could provide this information, we would be in a better position to provide an educational experience for the young people and to make the proper decision as to where to develop the park in an orderly manner. We can use the information to assist in making the following decisions:

1. Where to develop various scenic areas throughout the park for public access.
2. Where to develop parking lots and sanitary facilities so as to have minimum impact of the environment.
3. Where to locate trails for maximum scenic quality but minimum impact, at the same time including most of the identifiable ecological regions of the park.

4. Where to allocate the youth labor for maximum benefit to both the park and their field related experience.

There are four other critical areas in Kansas where similar material could be utilized by this agency for future decision making. These areas are listed in the order of importance as follows:

1. The Missouri River Bluffs Area between Kansas City and the Nebraska State Line.
2. The Flint Hills Area from the Nebraska State Line to the Oklahoma State Line.
3. The Strip Pits Area in Crawford and Cherokee Counties and Shoal Creek.
4. The Arkansas River Valley between Great Bend and the Colorado State Line.

Any future assistance that you may be able to provide in any of these areas would be of assistance to us. Thank you for your attention in this regard.

Sincerely,

Lynn Burris, Jr.
Director

LBjr:pd

cc: Mike Snyder

BY Wayne Herndon
Wayne Herndon, Planning Coordinator

STATE OF KANSAS
Forestry, Fish and Game Commission

Box 1028
XXXXXXXXXXXXXXX
XXXXXXXXXXX
2204 Vine
Hays, KS 67601

Ted Talmon
Univ. of Kans.
Space Tech. Center
2291 Irving Hill Dr.
Lawrence, KS 66045

Dear Ted,

Kansas' antelope program has now reached the stage where we can move pronghorn into unoccupied habitats. Our pronghorn herd should go over the 1,000 population mark when the annual winter survey is conducted this year, and this will provide a surplus of animals that can be transplanted.

Preliminary work has indicated that Kansas contains a minimum of six areas that should support a self-sustaining antelope population. These areas are widely separated by distance and man-made barriers, and each area will require at least one release of 30 animals.

Kansas will borrow the trapping equipment from Colorado and can be obtained every other year. One can see that the pronghorn transplanting program will take close to 15 years before completion. Estimated costs for the first trapping year have been placed at $9,540 and 110 man-days.

What I am leading to is that with this degree of time and effort, we want to be sure to fill our best areas (areas with greatest chance of success) first. This means that the six possible release areas will have to be rated and placed in a priority list. The following criteria will determine an areas rating: 1) the continuity and quantity of the rangeland and cropland, 2) the amount of man-made barriers, 3) the quality of the rangeland, 4) the intersperion of rangeland and cropland, 5) the degree and rate of cropland encroachment on rangeland, and 6) the attitudes of the landowners.

It is on points 1, 2, 4, and 5 that you could provide assistance and save time for the program. Points 1 and 2 will be used to determine the best area for pronghorn expansion. Large areas of cropland, railroads, highways, major rivers, and 5-stand barbwire fences (pronghorn go under not over fences) are a few barriers that will restrict antelope movements.

Point 4 will be useful in that an area's carrying capacity can be increased if the proper amount of wheat-land is scattered throughout the rangeland. Point 5 will be very beneficial especially if yearly changes from 1972 to the present can be obtained. It would not only be important to know the total amount of cropland encroachment since 1972, but also the yearly change so one could determine if the rate was increasing or decreasing. In other words, one area might show a higher degree of encroachment than another; but encroachment might be slowing down in the higher area and increasing in the lower area.

From preliminary work, the six potential release areas have been arranged in the following order;

1) Smoky Hill drainage in Logan, Gove, and Trego counties.
2) Clark, Meade, and Comanche counties.
3) Ellsworth, Russell, and Lincoln counties.
4) Flint Hills.
5) Morton County
6) Osborne County

But as pointed out above, additional information is needed to insure the proper selection for our first release since the future of the pronghorn program in Kansas could depend on that release.

Sincerely,

Kent Montei
Big Game Biologist

Kansas Fish & Game

BOX 54A, RURAL ROUTE 2, PRATT, KANSAS 67124
(316) 672-5911

REGIONAL OFFICES:

Northwest Regional Office
Box 366, 190 N. Franklin
Colby, Kansas 67701

Northcentral Regional Office
Box 489, 511 Cedar
Concordia, Kansas 66901

Northeast Regional Office
Forbes AFB, Box 19086
Topeka, Kansas 66619

Southwest Regional Office
808 Highway 56
Dodge City, Kansas 67801

Southcentral Regional Office
Box 764, 204 West Sixth
Newton, Kansas 67114

Southeast Regional Office
222 West Main Building
Suite C & D
Chanute, Kansas 66720

June 6, 1978

Ted Talman
Space Tech. Center
University of Kansas
2291 Irving Hill Drive
Lawrence, KS 66045

Dear Ted:

The information furnished by your department provided excellent data for the antelope project leader of the Kansas Fish and Game Commission.

As you are aware, we had hoped to obtain from other states between 200 and 300 head of antelope. We were able to travel to Wyoming where they allowed us to trap 100 head. This made the decision as to where these animals would best benefit the state very important. The remote imagery data allowed us to prioritize our potential release areas. It made the decision of where the 100 head of antelope were to be released much easier and provided a higher degree of potential success.

We appreciate your efforts in helping with our antelope program and hope this type of cooperation will continue.

Thanks again,

Kent

Kent Montei
Regional Wildlife Supervisor
Northcentral Region

AKM/cg

APPENDIX III:

Slide Shows

STRIP MINE LAND RECLAMATION IN SOUTHEAST KANSAS

Slide 1 Map of Kansas Showing Location of KF&G Areas

Between 1926 and 1969, twenty-six tracts of land at the twelve sites shown here in northern Cherokee and southern Crawford counties were acquired by the state of Kansas. These were either donated or sold to the state for one dollar because some ninety-four percent of the 6,000 acre area consisted of strip mine dumps.

Slide 2 Ground shot showing strip mine dump

In 1962 the Kansas Fish and Game Commission (KF&G) began an intensive program of management designed to enhance the fish and wildlife resources of these areas. This effort, however, met with considerable difficulty.

Many environmental problems such as the one shown here impeded the formulation and implementation of a comprehensive reclamation plan for recreation in the 26 tracts of land. The scattered location of the units throughout the two county area and the heterogeneous nature of each tract made it virtually impossible to design a beneficial reclamation program. The extensive heterogeneity of the tracts was due to topographic changes after mining, creation of numerous strip-mine lakes and ponds, radical changes in drainage patterns, wide differences in the amount and type of volunteer vegetation establishment, and the existence of highly acid sites that drain in to strip-mine lakes and streams. Past efforts focused on delineating and reclaiming the most obvious acid sites such as abandoned coal washing areas.

Slide 3 Air photo showing examples of reclamation problems

Large scale (1:20,000) color infrared aerial photography, June 1976, of the 26 tracts of land was enlarged to a scale approximately 1:5,000. These photos were provided to KF&G biologists. Kansas Applied Remote Sensing program (KARS) personnel assisted in the initial interpretation. Through the use of this high resolution aerial photography, KF&G personnel were able to identify problems associated with this 144 acre tract that had recently undergone a $40,000 reclamation program. It was determined from the photography that desirable vegetation cover had not become established and consequently was not controlling erosion. It was also apparent that overburdened areas were not adequately excavated during the reclamation

procedures. In addition, temporary pools of standing water were creating numerous drainage problems. The aerial photography was subsequently used by local KF&G personnel to demonstrate to KF&G administration the need for an additional $11,000 to correct problems on the 144 acre tract and protect their $40,000 investment.

Slide 4 Ongoing reclamation efforts

The KF&G administration subsequently allocated the additional $11,000 to extend the reclamation effects initiated earlier in this 144 acre tract. The administration also decided to increase the standing budget for reclamation activities from $10,000 to $20,000 annually. The activity resulting from the $11,000 allocation is seen here and apparently corrected the situation. However, KF&G personnel are now routinely acquiring aerial photography to evaluate and monitor the conditions at this tract and initiate reclamation activities in other KF&G areas.

Slide 5 Reclamation Area 7-10

Reclamation activities planned for 1978 include the reclamation of a coal washing site, development of a fishing ramp, trail and dam complex for access to new fishing areas and wildlife habitat improvement on seven acres of recently reclaimed land. Correct excavation practices of overburdened areas and subsequent seeding of grasses will decrease soil erosion and alleviate problems associated with acidic water. In addition, KF&G will acquire aerial photography in early spring to measure the total amount of water acreage that's available for development of sport fisheries. The 1978 program is estimated to cost $20,000.

SAND HILLS STATE PARK

Slide 1 Map of Kansas Showing Location of Sand Hills State Park

In the spring of 1977 the Kansas State Park and Resources Authority completed the acquisition of approximately 2 square miles of land in a scenic sand dune area of southeast Kansas. The area was designated as Sand Hills State Park and is located 3 miles northeast of Hutchinson, one of the largest population centers in the state. Because of the anticipated heavy use, it was necessary for the Park and Resources Authority to begin development of the park facilities during June. This development, however, was hampered by a lack of adequate land cover information on which to proceed. On May 11, 1977, State Park and Resources Authority Director Lynn Burris requested the assistance of the KARS Program regarding this project.

Slide 2 Ground Shot of Sand Dune

The focal point of the park is a series of very striking sand dunes, some of which are 40 feet high. These are very delicate ecological areas, only partially stablized by a thin cover of vegetation. In dune areas where vegetation is damaged or destroyed, wind erosion may rapidly extract its tool and create what is known as a "blowout." The key long-range concern of the park planners was to develop a master plan that would maximize scenic access to these dunes while minimizing physical contact with the ecologically delicate areas.

Of immediate concern was the problem of directing the work efforts of 30 teenagers hired under the federal Youth Conservation Corps Program (YCC) to aid in the park development at a cost of $30,000. This question was a particularly weighty one, since it was important to provide the young people with a meaningful field experience but at the same time ensure that their efforts did not run counter to the conservation and development goals of the planners.

Slide 3 Color Map of Park Area Land Use

In order to provide the Park and Resources Authority with the required land use information, the KARS Program used aerial photography to prepare a land use map of the area. This map at a scale of 1:9,600 depicted categories of land use that were of concern to the park planners and was very useful for an overview of the park. These categories included such features as high sand dunes, low sand dunes, bare sand areas, grassland, agricultural areas, roads, fences, wooded areas, marshes and water bodies.

Slide 4 Master Plan Map

The KARS land use/land cover map was used by KPRA to prepare a general development plan and a master plan map. The master plan map includes development for six nature study areas, six camping areas, seven picnic areas and several maintenance areas to accommodate the anticipated 100,000 visitors annually. In addition, service entrances, hiking trails, parking areas and a site for a star gazing amphitheater were chosen.

After the delivery of the KARS map and subsequent preparation of the Master plan, KPRA became impressed with the uniqueness of the Sand Hills area demonstrated by the maps. By comparison, they had received an allocation of $350,000 from the Secretary of the Interior for an adjacent tract of land that was less interesting ecologically. They subsequently decided to cancel the acquisition of the adjacent tract of land and reallocate the $350,000. They also recommended that $100,000 be allocated from Kansas funds for the construction of an interpretive center containing displays and information about the ecology and uniqueness of the Sand Hills. The Governor of Kansas accepted this recommendation and included it in his budget message to the Kansas Legislature in January, 1978.

Slide 5 Youth Conservation Corps at Work

Although the KARS Program received the request for assistance only 4 weeks prior to the arrival of the YCC workers, the aerial photography and preliminary land use map were in the hands of the Park planners in time to identify a constructive set of tasks for the YCC personnel. Among these tasks were:

1. Removal of all interior fences and repair of the perimeter fences.
2. Repair of the main pond facility dam and overflow system.
3. Renovation of a barn for use as a group shelter.
4. Construction and signing of a trail system in the north central portion of the park.
5. Construction of a secondary parking lot.

During the summer of 1977 all of these tasks were completed.

PRONGHORN ANTELOPE IN KANSAS

Slide 1 Pronghorn antelope

Through efforts of the Kansas Fish and Game Commission (KF&G), the pronghorn antelope (Antilocapra americana) population in Wallace and Sherman counties in western Kansas increased from approximately 60 individuals in 1963 to its present level of about 1,000 individuals. Because of this sizeable increase, hunting of antelope was permitted in Kansas for the first time in 1974. Response to this hunting opportunity was great as evidenced by the 500 requests received for the 80 permits issued. This success prompted KF&G to consider the possibility of stocking other areas in Kansas with antelope.

Slide 2 Kansas Land Use Map (showing outline of study areas and Flint Hills site)

The plan approved by KF&G involved the capture of 100 antelope in Wyoming and subsequent releases of 50 animals each in two areas in Kansas with suitable conditions. Pronghorn antelope populations require large expanses of rangeland with few man-made barriers. In addition, interspersion of such areas with small amounts of agricultural land planted with winter wheat is desirable because it increases winter forage in the area, thus allowing maintenance and survival of large populations. An excess of agricultural land, however, not only decreases the amount of suitable habitat, but also creates barriers to movement. On the basis of these criteria, one area, the Flint Hills, which is known to be the largest unbroken expanse of rangeland in the eastern portion of the state (largest yellow area on the map), was immediately selected from the Kansas Land Use Patterns map produced from LANDSAT imagery by the KARS Program in 1974.

Three other potential sites were also identified through use of the Kansas Land Use Patterns map. The first comprised parts of Logan, Gove, Trego, Lane and Scott counties in the far northwest corner of the state. The second site was composed of parts of eastern Ellsworth and western Saline counties located in central Kansas. The third site consisted of sections of eastern Meade county and the northern half of Clark counties in the far south central portion of the state. All three sites had the desirable habitat features, but also shared a common potential problem, namely agricultural

encroachment of rangeland. KF&G personnel, therefore, felt that a temporal evaluation of the conversion of rangeland to agricultural land was necessary before a final decision could be made concerning a specific release site for the remaining 50 antelope.

Slide 3 Landsat Monitoring of Cropland Encroachment on Rangeland

KARS personnel utilized three dates of LANDSAT imagery per year, covering the months May through September. Change in the distribution of cropland replacing rangeland was apparent on Landsat imagery for each of the years 1972-1976.

Slide 4 Interpretation of Landsat Image

Together with ground truth data obtained from low altitude ASCS photography and KF&G field personnel, maps portraying encroachment of agricultural land onto rangeland were compiled as shown in this slide. Bands five (5 - .6 to .7 μm) and seven (7 - .8 to 1.1 μm) were used for each date to depict the increasing frequency of the cropland category. Colored maps depicting the agricultural expansion for each of the three sites keyed to 1:250,000 scale USGS base maps were prepared. In addition, summary statistics of the percentage of rangeland and total acreage of rangeland converted to agriculture in each year were provided for each site.

Slide 5 Map of agricultural encroachment in Northwestern site

On the basis of these data KF&G found that the northwestern site (shown here), which had originally been favored because of its proximity to the area occupied by the highly successful western herd already in existence, was rejected because of rapid agricultural expansion which had consumed from 5 - 21% of existing rangeland each year. The Ellsworth - Saline County site was also judged to be less than desirable for similar reasons.

Slide 6 South Central Map

KF&G, thus, decided on the south central site because of the extremely slow expansion of agriculture, which averaged less than 1% per year.

Slide 7 Helicopter Hazing Antelope Into Trap

During January 1978, a seventeen man Kansas Fish and Game crew were sent to an area north of Cheyenne, Wyoming to capture one hundred antelope. A heli-

copter was used to haze this herd in the direction of a trap erected previously.

Slide 8 Antelope Corralled in Trap

The trap, shown in this slide, was borrowed from the Colorado Fish and Wildlife Department. It consisted of netting 250 feet long by eight feet high made of quarter inch rope with three inch mesh with a large gate at one end. Once the animals were trapped, they were checked by a veterinarian for disease, tagged and later loaded into a van.

Slide 9 Antelope Release

One load of sixty-three antelope was released in the south central site and thirty-seven were released at the Flint Hills site (southern Chase County). Pronghorn antelope may eventually be introduced into other areas determined suitable. Through these cooperative efforts, LANDSAT data are making a continuing contribution to the renaissance of this uniquely American big game animal in Kansas.

THE CONVERSION OF PRIME AGRICULTURAL LAND TO URBAN LAND USES IN THE KANSAS CITY METROPOLITAN REGION

Slide 1: Locational Map of the Kansas City Metropolitan Region

The Kansas City Metropolitan Region covers a 2,195,458 acre area in Kansas and Missouri. The Mid-America Regional Council (MARC) is responsible for coordinating the planning activities of the eight county region which includes one hundred and nine municipal governments.

Slide 2: Prime Agricultural Land Map of the MARC Region

In 1974, a soil survey was completed for the entire region as a part of the National Cooperative Soil Survey Program. One of the products of this survey was a map showing the distribution of prime agricultural land resources within the region as shown in this slide.

MARC officials were concerned about the effects that urban expansion was having on the region's prime agricultural land resources and in April 1975 contracted with the Kansas Applied Remote Sensing Program (KARS) to perform a study of the encroachment of urban land uses on prime agricultural lands.

Slide 3: Comparative Photography

Using NASA high altitude infrared imagery acquired over the region in October 1969 and May 1974 the extent of urban land use was mapped for each date.

Slide 4: MARC Region Prime Agricultural Land Map and Urban Expansion Overlay

The urban land use data were then compared with the prime agricultural land resources map produced by the soil survey. A total of 26,267 acres of new urban development occurred between 1969 and 1974. 10,727 acres of this development had occurred upon prime agricultural land, accounting for 40% of the urban development. This represented a 5% increase over the values generated by the 1969 data.

As a result of this study the Mid-America Regional Council has adopted a general policy in their 1977 publication, "Framework for Development," which states that any future development in the Kansas City Metropolitan Region should be planned with the objective of preserving existing agricultural land resources.

Slide 5: Johnson County, Kansas

The release of this data to individual county and municipal governments resulted in decisions at the county and municipal level. In Johnson County, Kansas, it was noted that the primary area of urban expansion was well removed from the bulk of the county's prime agricultural land resources. As a result, Johnson County has decided not to develop or implement a system for the protection of prime agricultural land resources at this time.

Slide 6: Platte County, Missouri

In contrast to the Johnson County situation, the portion of Platte County, Missouri which contains the Kansas City International Airport (Site A) has been threatened by considerable urban expansion. The county has therefore taken actions to restrict urban expansion drawn by the airport in an attempt to preserve both the rural and agricultural character of the county. Additional policies are being developed in response to the prime agricultural land study in Leavenworth Coutny, Kansas and Clay County, Missouri in an attempt to address problems related to urban expansion into rural portions of the counties which are adversly affecting the agricultural communities.